SURVEY REPORT

SAVANNAH RIVER WATERSHED

NORTH CAROLINA · SOUTH CAROLINA · GEORGIA

program for runoff and waterflow retardation - and soil erosion prevention

U. S. D. A.

U. S. DEPARTMENT OF AGRICULTURE

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UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY REPORT

SAVANNAH RIVER WATERSHED

NORTH CAROLINA, SOUTH CAROLINA, AND GEORGIA

Program for Runoff and Waterflow Retardation and Soil Erosion Prevention

Pursuant to the Act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented by the Act approved August 28, 1937 (50 Stat. 876)

March 1951

C O N T E N T S

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FIGURE - I
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H H BENNETT, CHIEF
SOUTHEASTERN REGION
BUIE REGIONAL DIRECTOR
SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA
SHOWING
PHYSICAL LAND UNITS
MOUNTAIN - FOOTHILLS
PIEDMONT PLATEAU
COASTAL PLAIN
TOWNS
MACON
JACKSON
TRANSYLVANIA
PICKENS
Pickens
RABUN
OCONEE
HABERSHAM
STEPHENS
Toccoa
BANKS
FRANKLIN
HART
ANDERSON
Anderson
JACKSON
MADISON
ABBEVILLE
Elberton
ELBERT
GREENWOOD
CLARKE
OGLETHORPE
McCORMICK
McCormick
SALUDA
EDGEFIELD
WILKES
LINCOLN
GREEN
TALIAFERRO
McDUFFIE
COLUMBIA
AUGUSTA
Thomson
AIKEN
WARREN
RICHMOND
GLASCOCK
JEFFERSON
BARNWELL
BURKE
ALLENDALE
JENKINS
SCREVEN
Sylvania
HAMPTON
JASPER
EFFINGHAM
BEAUFORT
CHATHAM
SAVANNAH
SAVANNAH RIVER
Seneca River
Tugaloo River
Broad River
Beaverdam Cr.
Little River
Brier Creek
Hudson River
Rocky River
N
LOCATION MAP
N.C
S.C
GA.
SCALE IN MILES
REV-6 28-50
6-5-39

INTRODUCTION

Authority

This report is submitted under the provisions of the Act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented by the Act approved August 28, 1937 (50 Stat. 876).

Purpose and Scope of Report

The purpose of this survey report is to outline a program of runoff and waterflow retardation and soil erosion prevention for the Savannah River Watershed in North Carolina, South Carolina, and Georgia; and to present recommendations for the installation and maintenance of the program together with an analysis of the costs and benefits thereof.

RECOMMENDATIONS

It is recommended that a program of runoff and waterflow retardation and soil erosion prevention be installed during a 15-year period in the Savannah River Watershed at an estimated cost of $14,090,000 to the Federal Government and $7,212,400 or its equivalent[1] to local interests, making an estimated total cost of $21,302,400 for installing the recommended program.

The program will be operated and maintained at an estimated annual cost of $146,600 to the Federal Government and $11,975,000 or its equivalent to local interests, making an estimated total annual cost of $12,121,600 for operation and maintenance. Of the amount to be expended by local interests, $11,454,700 or its

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1/ Labor, materials, equipment, land, easements, rights-of-way, and other contributions in lieu of cash payment.

equivalent will be expended by farm owners and operators or corporations and other private interests under agreements with soil conservation districts or other agencies of government for maintaining conservation measures, and for operating a more profitable system of conservation farming and woodland management. The remaining $520,300 or its equivalent will be expended by a local agency or agencies acceptable to the Secretary of Agriculture for operating and maintaining those installations which are not considered a part of farm, commercial timber, or corporation operations.

The recommended program has as its objectives the reduction of flood water and sediment damage and the conservation of soil and water resources. The interdependent measures that will accomplish these objectives are as follows: Subwatershed waterways, gully stabilization and sediment control, erosion control along roads and railroads, field diversions, terraces, perennial vegetation, pasture improvement, field border plantings, farm waterways, adequate fire protection, tree planting for cover restoration, cover improvement of privately-owned woodlands, public acquisition of watershed lands, development and management of acquired lands, control grazing in woodlands, tributary channel improvement and streambank stabilization, and other soil and water conservation practices and measures applied in proper combination with measures listed above to complete a basic system of soil and water conservation in accordance with the needs and capabilities of the land.

Educational assistance and technical services provided under this program will be synchronized and adapted toward the specific objective of flood damage reduction.

The Secretary of Agriculture may make such modifications or substitutions of the measures described in this report as may be deemed advisable due to changed physical or economic conditions or improved techniques, whenever he determines that such action will be in furtherance of the objectives of the recommended program.

It is estimated that the recommended program will yield an average annual flood-control benefit of $498,200. In addition to this flood-control benefit, an estimated average annual benefit of $22,961,600 from erosion control, conservation farming, and woodland management will accrue to private owners and operators of farm land and woodland and to railroads and highways.

The estimated average annual value of the benefits evaluated in this report is 1.36 times the average annual value of the total cost of the recommended program.[1/]

The recommended measures will be installed on non-Federal land under cooperative arrangements with State and local governments, soil conservation districts, or other agencies acceptable to the Secretary of Agriculture.

The program herein recommended includes the intensification, acceleration, and adaptation of certain activities under current

1/ Comparison of benefits and costs is based on future price and cost levels assumed to prevail under an intermediate level of employment.

programs of the Department of Agriculture, and additional measures not now regularly carried out in such programs, all of which are necessary to complete a balanced runoff and waterflow retardation and erosion control program. It is recommended that the Secretary of Agriculture be authorized to carry out this program. The extent to which the work recommended in this program is to be carried out under authority of the Flood Control Act as requested herein or under other authorities will be considered by the Secretary in requesting appropriations for the conduct of the recommended program. Although the current activities of the Department primarily related to the Flood Control Act are not included in the program herein specifically recommended, this program is based on the continuation of such current activities at least at their present level. The extent to which the measures in the recommended program may be carried out by an increase in the current programs of the Department will be taken into account in requests for the appropriation of funds to carry out the recommended program.

The authority of the Secretary of Agriculture to prosecute the recommended program shall be supplemental to all other authority vested in him, and nothing in this report shall be construed to limit the exercise of powers heretofore or hereafter conferred on him by law to carry out any of the measures described herein or any other measures that are similar or related to the measures described herein. The Secretary of Agriculture may construct such buildings and other improvements as are needed to carry out the measures included in the recommended program.

DESCRIPTION OF THE WATERSHED

The Savannah River Watershed comprises an area of 10,579 square miles. Approximately 5,870 square miles or about 55 percent of the watershed lies in Georgia, 4,530 square miles or 43 percent in South Carolina, and 179 square miles or 2 percent in North Carolina (fig. 1). Land in farms comprises 61 percent of the total area.

The headwater area of the Savannah River is on the southern slope of the Blue Ridge Mountains in northeastern Georgia and southwestern North Carolina. It discharges into the Atlantic Ocean below Savannah, Georgia. The main headwater tributaries are the Tugaloo and Seneca Rivers which join in the Upper Piedmont Plateau to form the Savannah River proper. Tributaries with considerable drainage area in the Piedmont Plateau are Rocky River, Little River, and Stevens Creek, South Carolina, and Broad River and Little River, Georgia. The chief Coastal Plain tributary is Brier Creek, Georgia.

The watershed has three major physiographic areas, namely, the Mountain-Foothills, the Piedmont Plateau, and the Coastal Plain.

The Mountain-Foothills area, comprising 14 percent of the watershed, is a steep, rugged area of relatively thin, acid soils with narrow fertile bottom land along the major streams. Stream gradients are high. Erosion is moderately severe and runoff is very rapid.

The Piedmont Plateau, comprising 52 percent of the watershed, is a rolling to steeply rolling area of relatively deep acid soils.

Moderate to severe sheet and gully erosion affects most of the upland area. Sediment damage is a serious problem on the flood plains.

The Coastal Plain area, comprising 34 percent of the watershed, is predominantly a flat to gently rolling area of deep, sandy soils. Stream gradients are low and flood plains are very wide.

Stream banks are generally well vegetated throughout the watershed. Caving of stream banks is of common occurrence. On the main stem and major tributaries adequate channels are being maintained. The smaller tributaries in the Piedmont area are characterized by very poor channel conditions.

Agriculture has been developed intensively on the Mountain-Foothills flood plains which comprise 3.4 percent of the Mountain-Foothills area. About 7 percent of the Piedmont area is flood plain. Swamping and deposition of infertile sediments have made a large part of the Piedmont bottom lands unsuitable for agricultural use. The Coastal Plain bottom lands are inherently wet and subject to frequent flooding.

In 1945 approximately 60 percent of the watershed was in woodland, 22 percent in cropland, 6 percent in pasture, 7 percent idle, and 5 percent in miscellaneous uses. Most of the woodland is in poor to medium condition in terms of runoff and soil stability because of fire, grazing, overcutting, improperly maintained roadways, and destructive logging practices. Much of the openland is seriously eroded due to poor management practices. Pastures are largely unimproved and overgrazed.

The average annual precipitation, based on long term records of the U. S. Weather Bureau, ranges from 82 inches in the mountains of North Carolina to 43 inches at the mouth of Broad River in Georgia.

The population of the watershed in 1940 was approximately 640,000, of which about 64 percent resided in rural areas. Compared to 1930, an increase of 12 percent in total population was indicated by the 1940 Census. Farm tenancy decreased 5 percent from 1940 to 1945 when 46 percent of farm operators were owners. Farm tenancy ranges from a low of 33 percent in the Mountain-Foothills to a high of 59 percent in the Piedmont Plateau.

Agriculture is the leading enterprise with cotton as the major cash crop. Corn is also of major importance. Other important crops are small grains in the Piedmont Plateau and peanuts and watermelons in the Coastal Plain. Livestock farming is generally increasing. Important industries include textiles, cottonseed and peanut processing, foundries, fertilizer plants, naval stores, lumber, pulpwood, and other forest products.

The watershed is served by a good system of highways and railroads. River traffic extends upstream to Augusta.

FLOOD PROBLEMS

The largest and most damaging floods generally occur during the months of August, September, and October as a result of storms associated with West Indian hurricanes.

Violent local storms in the mountain area create damaging flash floods during crop seasons. More frequent prolonged rains cause overflows of longer duration in the tributary areas of the Piedmont Plateau during crop seasons.

For the watershed as a whole the greatest number of flood producing storms occurs during the first four months of the year. The highest rates of runoff occur on the untreated open land and in the grazed, heavily overcut, and repeatedly burned woodland. Approximately 58 percent of the Mountain-Foothills and Piedmont Plateau areas is now in woodland. Of this woodland area 78 percent is classed as poor in terms of runoff retardation.

The most critical runoff and sediment source areas are in the Mountain-Foothills and Piedmont Plateau. Gullies are a major source of the coarse sediment causing serious damage to stream channels and flood plain lands. There are over 400,000 acres of land in the watershed damaged by frequent to very frequent gullies.

Sediment and related damages are of minor importance in the Coastal Plain and Mountain-Foothills. In the Piedmont Plateau the deposition of coarse sand and other infertile material has damaged 7.4 percent of the bottom land. Scouring has damaged 4.6 percent of the flood plain. Swamping has caused serious land damage to 47 percent of the flood plain.

Reservoir storage capacities are generally being reduced by sediment deposits. Many reservoirs have already been filled.

The costs of treating public water supplies have been increased by highly turbid runoff.

Sediment damages to navigation and drainage channels, public health, crops, and property have been recognized but were not evaluated in this report. The effect of reduced turbidity on fish values was considered, but the benefits were not entered as part of the monetary justification for the remedial program.

The estimated average annual monetary damages are distributed as follows: Floodwater damage to crops and pastures, 35 percent; reservoir sedimentation damage, 10 percent; added cost of water treatment, 10 percent; land damage including sanding, swamping, and scour, 15 percent; and damage to roads and railroads, 30 percent.

Table 1 lists the estimated average annual monetary damages.

Table 1

Estimated Average Annual Monetary Damages in the Savannah River Watershed

Type of Damage	Average Annual Damages (1947 Prices)	
	Dollars	
Floodwater Damages		
Agricultural - crop and pasture	562,000	
Non-agricultural - urban and public utility	481,000	
Sub-total		1,043,000
Sediment and Land Damages		
Reservoir sedimentation	170,000	
Water treatment costs	157,000	
Land damage (sanding, swamping, and scour)	254,000	
Sub-total		581,000
Total Average Annual Damage		1,624,000

ACTIVITIES RELATED TO FLOOD CONTROL

The United States Department of Agriculture is actively cooperating with State and local agencies in carrying out programs for the conservation of soil, water, and timber resources in this watershed. The Forest Service administers and protects approximately

378,000 acres of National Forest land which were acquired for watershed protection and timber production. These lands on critical headwaters are given intensive fire protection and proper forest management. The Department, through the Forest Service, cooperates with State forestry agencies in protecting private woodlands against fires, providing technical assistance to owners in proper management of their woodlands, and making trees available for reforesting open or poorly stocked forest land. The Production and Marketing Administration provides direct aids to farmers for carrying out soil and water conservation practices. The Department cooperates with the State Extension Services and Experiment Stations in educational and research work in the conservation of soil and water resources. The Soil Conservation Service is currently assisting soil conservation districts in the planning and application of soil and water conservation measures on farm lands. The present annual Federal cost of those portions of the Department's "going" programs which promote measures aiding in flood control and/or associated benefits is approximately $1,171,700.

The Department of the Army, Corps of Engineers, has recommended a comprehensive plan of improvement for the Savannah River Basin, consisting of 11 developments for hydroelectric power, flood control, navigation, and other uses. This plan is described in House Document No. 66, 76th Congress; House Document No. 657, 78th Congress; House Document No. 6, 81st Congress. The Clark Hill multiple-purpose reservoir is now under construction and when completed will provide some protection to approximately 240,000

acres of potentially good agricultural bottom land below Augusta. A navigable channel 90 feet wide and 9 feet deep, extending from The Savannah Harbor to the present head of navigation at Augusta, Georgia, and the Hartwell multiple-purpose reservoir have been authorized.

The Hartwell multiple-purpose reservoir will provide additional protection against floods up to a frequency of once in 10 years to the 240,000 acres of bottom land below Augusta.

The Georgia Power Company has developed a series of six power dams on the Tallulah and Tugaloo Rivers. Present operation of these reservoirs aids in flood reduction to some extent, since the power company has occasionally drawn down the pools in anticipation of high flow during storm periods.

The United States Department of the Interior administers the Savannah River National Wildlife Refuge consisting of 12,655 acres in Chatham County, Georgia, and Jasper County, South Carolina.

In 1950, soil conservation districts organized under State laws covered the entire watershed with the exception of a small portion of Towns County, Georgia, and small areas of the North Carolina counties of Transylvania, Jackson, and Clay. A program of soil and water conservation and land management on farm lands is being developed by soil conservation districts with technical assistance from the Soil Conservation Service and with the cooperation of other Federal, State and local agencies.

Map shows Macon

The United States Department of Commerce, through the Weather Bureau Office at Augusta, Georgia, forecasts gage heights during flood periods. It is expected that this service will be continued.

Approximately 25 legally organized drainage districts have been formed in the South Carolina and Georgia portions of the watershed. These districts, affecting an area of 68,000 acres and representing a capital investment of nearly $1,000,000, have generally been inactive in recent years.

The Highway Departments of the States have been applying erosion control measures on cut and fill slopes and road ditches.

RECOMMENDED PROGRAM

The program of runoff and waterflow retardation and soil-erosion prevention recommended in this report was developed from a study of representative sample areas. The present condition of the sample watershed land areas and minor watercourses was considered in detail to determine types and quantities of measures that would be most effective in reducing floodwater and sediment damages. The data derived by the sampling procedure were applied to physical land units to estimate total requirements of the most beneficial and practical works of improvement for runoff and waterflow retardation and soil erosion prevention.

The recommended program will accomplish a substantial decrease in floodwater and sediment damage and an increase in the productivity of watershed lands. The proposed measures are primarily for retarding or controlling water from the time the rain falls on the land until excess flows are discharged into major streams. These measures, installed in the proper combination and sequence, will be necessary to provide for the most practical and effective utilization of rainfall and orderly management of runoff.

Since the program of recommended measures was developed to function as a whole, each integral measure is designed to function most effectively in combination with others.

The program is planned for completion during a period of 15 years. Works of improvement will be installed, operated, and maintained largely by the landowners, operators, and other local interests. The scheduling of Federal participation and the completion of the recommended program will be dependent upon the rate at which local cooperation develops.

The recommended program consists of the following interrelated and interdependent measures for both flood control and conservation that will function to conserve soil and water, improve infiltration, retard runoff and increase soil fertility. The approximate number of each of these measures is shown in table 2.

Subwatershed Waterways. The waterways on individual farms discharge storm runoff into secondary channels which extend through other farms and finally discharge into tributary streams. Concentrated volumes of uncontrolled runoff produce excessive scour in secondary channels which seriously clogs streams. In addition, serious damage results to bottom lands by deposition of harmful sediment. Reshaping of waterways to obtain broad watercourses of adequate capacity with low velocities of flow as well as the application or installation of protective vegetation and structural controls for stabilization will be required to reduce this flood and sediment damage. Waterways extending entirely across flood plains to the tributary stream outlets will

be necessary to dispose of surplus water satisfacorily.

It will be necessary to construct channel outlets across the flood plains to tributary streams for proper disposal of water from hill lands. Clearing operations and stream bank stabilization and grading will be necessary on some secondary streams.

Structures will be necessary to handle critical runoff or sediment movement. In the design of water disposal systems for subwatersheds it is desirable to incorporate a small amount of floodwater storage in some of the structures in order to reduce the installation cost of other measures in the system. These small detention type floodwater storage measures are recommended for use in water disposal systems as stabilizing measures in headwater areas. They will consist of small earthfill dams with an outlet to release water at a fixed and safe rate and with auxiliary spillways adapted to site conditions. Since these installations will be small, their effectiveness will be most beneficial in reducing the installation cost of control measures immediately below the site. They will also produce additional benefits by furnishing some protection to flood plain lands and improvements. Approximately 440 miles of subwatershed waterways will require treatment.

Gully Stabilization and Sediment Control. Gullies are one of the principal sources of sediment and act as sluiceways in accelerating runoff to further aggravate flood problems during periods of heavy rains. In gully treatment work vegetative stabilization with perennials such as Lespedeza sericea, grass,

kudzu, and shrubs will be emphasized. Mulching, small check dams, and other structures will be employed where necessary. Drainage above the gullies will be diverted into stabilized waterways by the use of diversion ditches when feasible. Gully stabilization work is designed to decrease the volume of silt originating in active gullies, to reduce the rate at which land is being damaged, and to retard the present rapid rate of runoff as a means of protecting lower lying lands. Below critical gully areas, or at a point of concentration of a sediment producing area, it may be necessary to construct earth dams for sediment control. These will be supplemented with deep rooted shrubby perennials or trees as necessary. Three thousand six hundred ninety miles of major gullies will require stabilization.

Erosion Control along Roads and Railroads. Unprotected cut and fill slopes along roads and railroads are major silt source areas. Maintenance costs are also higher on such unprotected slopes. The recommended program provides for reshaping and vegetating such slopes and for vegetative and mechanical measures essential for more orderly control and disposal of storm runoff in ditches on road and railroad rights-of-way. This treatment will reduce maintenance costs and significantly retard runoff and sediment movement in the watershed. Treatment is recommended for 10,570 miles of roads and 310 miles of railroads.

Field Diversions. Field diversions will generally be installed on slopes too steep for terraces when orderly disposal of surface runoff is necessary for the protection of lands lying

immediately below. Approximately 1,150 miles of diversions are recommended.

Terraces. Terraces will be installed to manage runoff from sloping lands, principally those in cultivation, and to reduce soil erosion damage. Approximately 18,090 miles of terraces are recommended.

Perennial Vegetation. Deep-rooted perennial grasses and legumes will be established on 15,600 acres of land to retard runoff and erosion. These perennials will provide desirable forage for livestock.

Pasture Improvement. About 11,500 acres of old pasture lands need additional treatment such as fertilizing, liming, seeding, and other renovating measures. This treatment will serve a dual purpose in the recommended program: First, it will provide good ground cover which will reduce runoff and erosion; and second, it will furnish additional grazing for increased livestock production.

Field Border Plantings. Small, irregular, and inaccessible areas, as well as narrow strips of land along field borders, often left idle, are sources of serious erosion and present runoff problems. It is proposed that this condition be corrected by planting approximately 9,300 acres of such areas to adapted plants that will control erosion and produce food and cover for wildlife. Fences will be provided where necessary to furnish protection from grazing.

Farm Waterways. Farm waterways will consist of both natural and artificial watercourses to provide safe disposal of excess water from farms. Farm waterways will be vegetated and will include

such measures as broad meadow strips, constructed channels, and terrace outlets. The topography of adjacent farms will determine the planning and installation of water disposal systems. Waterways will usually extend from the top of terraced slopes to suitable outlets. It will be necessary for waterways to cross flood plain lands to reach suitable outlets. The proper disposal of excess water from farm land into adequate outlets will reduce erosion damage. Supporting structures will be installed to implement vegetative control where necessary. It is estimated that 28,600 acres of farm waterways will be needed.

Adequate Fire Protection. Adequate fire protection is required for approximately 2,221,000 acres of woodland. This involves use of personnel, equipment, and structures in preventing and suppressing forest fires. Adequate fire control will be one of the major factors in increasing infiltration and water-holding capacities of forest soils and in reducing erosion.

Tree Planting for Cover Restoration. Tree planting is required on approximately 140,100 acres of eroding open land and inadequately stocked woodland to restore protective cover, increase infiltration, and stabilize soils.

Cover Improvement of Privately-Owned Woodlands. The improvement of tree cover is necessary on approximately 1,095,000 acres of privately-owned woodland. These cultural, harvesting, and utilization practices will increase density and vigor of timber stands and maintain forest in optimum condition for water intake and storage.

Public Acquisition of Watershed Lands. The acquisition for watershed protection of 320,000 acres of depleted privately owned land within the Chattahoochee, Nantahala, and Sumter National Forests is recommended to assure continuity of management for the purpose of rehabilitating the cover for runoff and sediment control. The lands proposed for acquisition are in poor hydrologic condition due to over-cutting, grazing and fire. Slow growth rates, due to naturally poor sites and to depletion of fertility by erosion and excessive use, prevent economic rehabilitation of these lands for flood control purposes under private ownership. The lands will be acquired only through voluntary sales by the owners, and Federal acquisition will be contingent on obtaining such consents of State and local governments as may be required by law. It is contemplated that such lands will be administered as part of the national forest system.

Development and Management of Lands to be Acquired. This is to assure that the 320,000 acres of land recommended for public acquisition in the interests of flood control will be put in good condition for water absorption and retention.

The measure involves use of personnel and facilities in administering the lands for watershed protection and the production of timber and forage. It includes construction and maintenance of roads, communication systems, and other administrative facilities; and the year-to-year management activities which contribute to cover improvement.

<u>Tributary Channel Improvement and Stream Bank Stabilization.</u> Brushing, snagging, and establishment of suppressive and protective vegetation on stream banks are recommended on 1,180 miles of tributary streams. Channel dredging and realignments are recommended on 540 stream miles. The channel improvement work will regulate the movement of flood water, provide immediate reduction in tributary flood stages, and permit a more productive use of flood plain land.

<u>Other Soil and Water Conservation Practices and Measures.</u> Additional soil and water conservation practices and measures will be applied as needed. These will include any other farm woodland practices and measures which may be required to make more effective or to facilitate the installation of the above measures.

The quantities of measures included in the recommended program are based on total watershed needs less the estimated accomplishments under "going" programs of the Department over a 15-year period. The income of farm and woodland owners and operators is expected to increase materially as the recommended program becomes progressively more effective. No major change in the production of cash crops is involved but large acreage increases in pasture, perennial hay crops, and farm woodlands are recommended. It is expected that in making these land conversions the acreage of idle land would be reduced to a minimum.

<u>Educational Assistance.</u> Landowners and operators and others in the watershed will be furnished educational assistance in order to expedite the recommended program. Intensified educational efforts

will be directed toward familiarizing farmers with the specific measures essential to runoff and waterflow retardation and soil erosion prevention, and how to install and apply those measures not requiring the detailed assistance of a specialized technician, how to maintain such installations and measures, and how to integrate all into a sound farming system to produce the greatest benefit over a long period of time.

The Department is committed to a watershed and subwatershed approach in carrying out its responsibilities in the interest of flood control. It is essential that educational assistance provided under this program be directed toward furthering the specific objectives of floodwater and sediment damage reduction, and that it be fitted as to method and synchronization into subwatershed operations activities.

Technical Services. Technical services will be provided for (1) planning and applying woodland improvement measures and management practices for watershed protection, (2) planning and applying land use adjustments, (3) planning and applying conservation measures on the farm, and (4) integrating the installation of individual measures into a proper combination to achieve the most effective program of runoff and waterflow retardation and soil erosion prevention. These services are required to assist the people in the watershed in installing the recommended measures on their land and in adopting the recommended practices for their farm and woodland operations.

COST OF THE RECOMMENDED PROGRAM

The estimated cost of installing the recommended program in the Savannah River Watershed is approximately $21,302,400. Of this amount, it is estimated that the Federal Government will expend $14,090,000; non-Federal public agencies, $2,679,300; and private interests, $4,533,100. The estimate of total costs and the apportionment of costs to the Federal Government, non-Federal public agencies, and private landowners and operators are based on experience in the application of practices and measures similar to those recommended in this report.

Federal participation will include educational assistance, technical services, materials, planting stock, special equipment, and other direct aids where appropriate and needed to assist in the installation and maintenance of the recommended practices and measures.

The cost and the responsibility for the installation of any phase of the recommended program that is assigned in this report to the Federal Government may be assumed by state or local governments or responsible local agencies. It is anticipated that the estimated Federal cost can be reduced as a result of a greater realization upon the part of the landowners of the advantages of installing the recommended practices and measures. State and local agencies will be urged to participate in the program to the fullest extent possible so that they will bear a proportionate share of the cost commensurate with the benefits that will accrue to them.

The estimated average annual cost of operating and maintaining the recommended program is approximately $12,121,600. Of this cost, the Federal Government will expend $146,600; non-Federal public agencies, $520,300; and private interests, $11,454,700. The Federal Government will provide (1) any maintenance of measures installed by it that may be required from the time of completion of such measures to the time of their transfer in good condition to the operating and maintaining agency; and (2) one-half of the cost of maintenance of improved fire protection on non-Federally owned woodlands.

The estimated cost of installing the recommended program is shown in table 2.

Table 2

Estimated Cost of Installing the Recommended
Program in the Savannah River Watershed

Item	Unit	Approximate Number	Cost (1947 Prices)
			Dollars
Subwatershed waterways	Mile	440	946,500
Gully stabilization and sediment control	Mile	3,690	1,762,500
Erosion control along roads and railroads	Mile	10,880	1,890,200
Field diversions	Mile	1,150	140,000
Terraces	Mile	18,090	1,102,700
Perennial vegetation	Acre	15,600	645,800
Pasture improvement	Acre	11,500	357,400
Field border plantings	Acre	9,300	320,600
Farm waterways	Acre	28,600	987,000
Adequate fire protection	Acre	2,221,000	1,826,000
Tree planting for cover restoration	Acre	140,100	2,295,700
Cover improvement, privately-owned woodlands	Acre	1,095,000	817,000
Public acquisition of watershed lands	Acre	320,000	4,800,000
Development and management of lands to be acquired	Acre	320,000	776,000
Tributary channel improvement and streambank stabilization	Mile	1,720	2,635,000
Total			21,302,400

The cost of technical services, educational assistance, and administration of direct aids is included in the costs above. It is recommended that non-Federal public agencies bear one-half the cost of technical services on privately-owned woodland and one-half the cost of educational assistance.

[illegible]

BENEFITS FROM THE RECOMMENDED PROGRAM

The principal benefits that will result from carrying out the recommended program are reductions in floodwater damage, reductions in sediment and land damages, and associated benefits, such as open land conservation benefits, woodland benefits, and decreased maintenance costs on public roads and railroads.

Benefits from Reductions in Floodwater Damage

An important effect of the recommended practices and measures will be to reduce damages caused by small floods of frequent occurrence. Damages caused by medium sized floods will also be reduced although to a lesser extent. The benefit resulting from reducing floodwater damage accrues mostly to agriculture and includes about 90 percent of the estimated average annual benefit from reducing floodwater damage, or 32 percent of the annual flood control benefit. The major benefit to agriculture, mostly for crops and pasture, will occur on the tributary streams. Benefits will also accrue to industrial, commercial, residential, utility, highway, and railroad properties due to less damaging floods than are experienced under present conditions. The recommended program, when properly installed and adequately maintained, will reduce floodwater damages by an estimated 17 percent.

Benefits from Reductions in Sediment and Land Damages

Benefits related to sediment damages occurring in the watershed are of three principal kinds; reduction in the sedimentation of reservoirs, reduction in water treatment costs, and reduction in land damage.

Benefits from Increased Productivity of Bottom Lands

The recommended channel measures and associated works of improvement for controlling runoff will not only prevent swamping damage but will provide opportunities to rehabilitate poorly drained bottom lands subject to overflow through a reduction in flooding and by providing improved outlets that will permit better drainage of fertile bottom lands by the landowners and operators. Some of this land has a high capability for producing excellent yields of cultivated crops. Lands of lower capability when properly protected against floods and drained will produce moderate returns from hay and pasture. Approximately 40,000 acres of bottom land will be benefited from the recommended program. The benefit from this improvement comprises about 46 percent of the total average annual flood control benefit.

Benefits accruing through decreased rates of sedimentation and consequent extension of the life of reservoirs for water supply, power, and recreation purposes were evaluated for all reservoirs of importance. Reservoirs range in size from small channel types to the multi-purpose Clark Hill Reservoir with a planned storage capacity of 2,900,000 acre-feet. Silting rates range from low to very high. The recommended program, if carried out, will result in appreciable benefits to 9 reservoirs. The average annual damage to reservoirs by sediment will be reduced by an estimated 11 percent.

Most of the public water supply comes from surface sources and is treated before use. The recommended program will reduce the sediment content of the water and thereby decrease the annual cost of water treatment by an estimated 3 percent.

Sediment and land damages are classified as deposition of infertile materials, swamping, and scouring or washing away of the flood plain surface. These damages will be reduced an estimated 26 percent by the recommended practices and measures which will decrease sand movement and deposition, improve drainage conditions by lowering the water table in swampy areas, and reduce high velocity overflows which cause land scour.

Benefits accuring from all the reductions in sediment and land damages described above are estimated to be about 18 percent of the total average annual flood control benefit.

Associated Benefits

Other benefits evaluated in this report that will accrue from the installation of the recommended practices and measures include open land conservation benefits, woodland benefits, and decreased maintenance costs on public roads and railroads.

The open land conservation benefits evaluated in monetary terms consist of the direct benefits that will accrue to participating landowners and operators through increases in farm income.

The woodland benefits were derived from a determination of yields with and without the recommended program. It is expected that under proper management, the forest stands will be brought into full stocking. This will be accomplished by planting trees

for cover restoration, providing adequate fire protection, restricting the periodic cut to a portion of the annual growth until the stand is fully stocked, and other watershed woodland management practices. Comparative incomes on the basis of present conditions and conditions with the recommended program installed were used to estimate the average annual benefit of the woodland measures.

Eroded material washed from unprotected roadway and railroad cuts and fills obstructs ditches and culverts. About one-third of the total cost of roadway maintenance is chargeable to the removal of this material. Eventually some of this eroded material is washed downstream and causes damage to downstream channels. Highway maintenance figures from areas already treated indicate that treatment to stabilize cuts and fills and roadway ditches reduces maintenance costs by approximately 67 percent. The cost of maintenance operations along railroad rights-of-way also will be substantially reduced by stabilization measures for orderly disposal of storm runoff and control of erosion.

The estimated average annual monetary benefit resulting from the recommended program is shown in table 3.

Table 3

Estimated Average Annual Benefit from the Recommended Program for the Savannah River Watershed

Source	Average Annual Benefit (1947 Prices)	
	Dollars	
Reductions in Floodwater Damage		
Agricultural - crop and pasture	160,500	
Public roads and railroads	17,000	
Sub-total		177,500
Reductions in Sediment and Land Damages		
Reservoir sedimentation	19,200	
Water treatment costs	4,900	
Land damage (sanding, swamping, scour)	66,800	
Sub-total		90,900
Increased Productivity of Bottom Land	229,800	229,800
Total Average Annual Flood Control Benefit		498,200
Associated Benefits		
Open land conservation benefit	6,330,000	
Woodland benefit	16,359,300	
Decreased maintenance costs on public roads and railroads	272,300	
Sub-total		22,961,600
Total Average Annual Benefit		23,459,800

COMPARISON OF BENEFITS AND COSTS

Based on prices and costs expected to prevail under intermediate employment levels during the period 1955 to 1965, the ratio of the average annual benefit to the average annual cost is 1.36 to 1.

SURVEY REPORT

(APPENDIXES)

SAVANNAH RIVER WATERSHED

NORTH CAROLINA · SOUTH CAROLINA · GEORGIA

program for runoff and waterflow retardation - and soil erosion prevention

U. S. DEPARTMENT OF AGRICULTURE

MARCH 1951

NOTE

Certain discrepancies exist between the report and these appendixes in connection with the acreage to be treated by forest land measures, the cost of such measures, and the benefits to be derived from them. Details concerning these discrepancies are shown on page 30, Appendix D.

C O N T E N T S

Appendixes:

APPENDIX A

PHYSICAL FACTORS

SAVANNAH RIVER WATERSHED

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GENERAL DESCRIPTION

The Savannah River Watershed (Figure A-1) in Georgia, South Carolina, and North Carolina has a total area of 10,579 square miles. The headwater area is on the southern slope of the Blue Ridge Mountains of northeastern Georgia and southwestern North Carolina. The headwaters form three of the main tributaries of the Savannah River; namely, the Tallulah River, Chattooga River, and Keowee River. The first two unite to form the Tugaloo River. The Keowee River, below the mouth of Twelvemile Creek, becomes the Seneca River. The confluence of the Tugaloo and Seneca Rivers marks the beginning of the Savannah River proper, 50 airline miles south of the headwater area, on the Piedmont Plateau.

Below this confluence, the main tributaries on the Piedmont Plateau include Rocky River, Little River, and Stevens Creek, South Carolina, and Broad River and Little River, Georgia. The Savannah River crosses the fall zone 92 river miles southeast of the confluence and enters the Coastal Plain at Augusta, Georgia.

From there, the river flows generally southeast along a meandering course of 222 river miles to Tybee Roads, where it discharges into the Atlantic Ocean. The chief Coastal Plain tributary is Brier Creek, Georgia. The lower 50 miles of the Savannah River is tidal.

The entire Savannah River Watershed has been divided into three Physical Land Units in order to develop and evaluate the proposed program. These are major separations made on the basis of similarities with respect to vegetative cover, soils, geology, and stream characteristics. These are important factors which influence runoff and flood control. Figure A-1 is a map of the watershed showing the Physical Land Units. They are described briefly below.

Mountain-Foothills

The Mountain-Foothills Physical Land Unit comprises 14 percent of the entire watershed. It consists of the Blue Ridge Mountains and its southeastern Foothills. Elevations range from about 1000 feet to 4,930 feet above sea level. The underlying rock is crystalline, and is predominantly gneissic and schistose. The streams have high gradients. In the Mountains, the flood plains are narrow and poorly developed, whereas in the Foothills, the flood plains include more widely developed alluvial areas. Soils range from thin mountain soils to foothill soils, some of which are similar to but not as well developed as those on the Piedmont Plateau. About 84 percent of the Mountain Area is woodland of which approximately 40 percent is Apalachian hardwoods. The balance is a mixture of shortleaf pine and upland hardwoods, with some Virginia

pine on the ridges. Woodland covers about 63 percent of the Foothills Area. It is largely a mixture of shortleaf pine and upland hardwoods with an appreciable amount of Virginia pine.

Piedmont Plateau

The Piedmont Plateau includes the crystalline rock portion, 45 percent; and the "slate" belt, 7 percent; or a total of 52 percent by land area of the Savannah River Watershed. The northwestern border of the plateau is an irregular line with the steeper, more highly dissected foothills at an average elevation of 1000 feet. The plateau is an upland remnant of a former peneplain into which the Savannah River and its tributary streams have incised their channels, and rolling to steep hills have been formed by normal geologic erosion. The surface of the plateau has an average southeastward slope from the Foothills to the fall zone of 6 feet per mile. Along the fall zone, the plateau rocks pass beneath the Coastal Plain formations at elevations ranging from 150 to 600 feet above sea level.

About 54 percent of this area is woodland, of which about one-half is mixed shortleaf pine and upland hardwoods. On the rest of the area loblolly pine occurs in mixture with those tree species.

Coastal Plain

The Coastal Plain comprises 34 percent of the watershed. It consists of unconsolidated and semi-consolidated sands, clays, and marls, thin at the northern margin, but gradually increasing in total thickness southward and attaining depths of several thousand feet. Beneath these sedimentary formations lie the southward extension of the igneous and metamorphic rock mass of the Piedmont Plateau. The upper portion of the Coastal Plain includes fall zone sand hills which are gently to steeply rolling; the middle portion includes undulating sands, loamy sands, and sandy loams; and the nearly flat lower Coastal Plain includes a high percentage of imperfectly or poorly drained soils. Flood plains are wide and well developed, and stream gradients are low. The land inundated by extreme floods along the Savannah River ranges from 2 to 5 miles wide between Augusta, Georgia, and Tybee Roads. About 64 percent of this portion of the watershed is woodland. Some 44 percent of the forest cover is mixed loblolly pine and upland hardwoods, and equal amount is longleaf pine, and the rest is bottom hardwoods which occur along the lower reaches of the principal streams. On the coast the bottom hardwoods give way to small areas of tidal marsh which support little, if any, tree growth.

The following table gives the areal distribution of Physical Land Units by states.

DISTRIBUTION OF PHYSICAL LAND UNITS BY STATES

(Acres)

Physical Land Unit	South Carolina	North Carolina	Georgia	Total
Mountain-Foothills	473,800	114,560	323,110	911,470
Piedmont Plateau	1,493,370		2,050,550	3,543,920
Coastal Plain	932,030		1,383,140	2,315,170
Grand Total	2,899,200	114,560	3,756,800	6,770,560
Total Sq. Mi.	4,530	179	5,870	10,579
Percent	42.8	1.7	55.5	100.0

LAND USE CAPABILITIES

Conservation surveys made by the Soil Conservation Service in the Savannah River Watershed are the basis for land use capabilities. The land capabilities from the conservation survey samples were expanded to the problem areas in soil conservation. Soil conservation problem areas are fairly broad areas outlined in accordance with general land conditions which determine the nature of the conservation problems. The land use capabilities for each physical land unit were obtained by summarizing the land capabilities of the soil conservation problem areas.

Table A-1 is a summary of the distribution of land use capability classes by present land use.

RUNOFF

It is estimated on the basis of data accumulated during the course of the survey that less than 5 percent of land area in the Piedmont Plateau and 10 percent in the Mountain-Foothills has as great infiltration rate and water storage capacity as were existent in pre-modern times. Improper land use and inadequate conservation treatment have caused these conditions. As a result, the rate and amount of runoff has increased.

In order to consider how conversions of land use would be effective in reductions of runoff, changes to be made are listed in six broad categories as follow:

1. The remedial program would convert the larger portion of woodland in poor or medium hydrologic condition to good hydrologic condition. Woodland in good hydrologic condition will be maintained as such. A small portion of the woodland occurs on soils of very low infiltration rates. These low rates may represent the natural condition of the soil or be the result of severe sheet erosion or other land misuse. Even under the best of management the infiltration rates on these areas can be increased only slightly.

2. All idle land would be converted to cropland, pasture, perennials, wildlife, or woodland, according to its land use capability and needs.

3. All cropland of capability classes I, II, and III, and part of IV, will be retained as cropland. Soil conservation practices such as improved rotations, permanent vegetative strips and properly built terraces along with contour cultivation will result in consequentially improved hydrologic condition of the land retained as cropland.

4. A part of land now cultivated of Class IV and all land now cultivated of Classes VI and VII will be converted to pasture, perennials, wildlife, or woodland.

5. Pasture improvement and management will improve the water retention capacity of pastured areas, thereby reducing runoff.

6. Miscellaneous areas consist of farm home sites, urban areas, lakes, stream channels, roadways and railways. Drainageways, cuts, and fills along roadways and railroads are recommended to be stabilized. There will be little or no reduction of runoff in the other areas.

Infiltration Formula Method

The infiltration formula method, which is based on data covering areas scattered over the entire United States, represents average conditions for the entire country. This has been devised to develop a simplified method to determine the effect of improved soil and cover conditions on runoff.

In applying this method, it is necessary to have basic information of the soil and cover conditions for the watershed on which runoff determinations are to be made. Data were assembled, first, to show the distribution of soil textural groups by cover under existing land use conditions; and, second, to show the distribution of soil textural groups by cover after the remedial land use program is in full effect. The textural groups are based on field determination and/or mechanical analysis of the sand, silt, and clay fractions. This is taken from tabulated data, published or unpublished for areas where soil surveys have been made. This classification is solely for use in the infiltration formula, and may group soils not similar in other respects. The extent of distribution of each group was based on measured soil conservation surveys or other type of measured soil surveys. The present cover distribution was based on soil conservation surveys, soil conservation district reports, and the U. S. Census of Agriculture. Future cover conditions, after the remedial flood control program is in full effect, were based on the best conservation measures for the land as indicated by the land use capabilities and economic factors involved.

EROSION

Upland areas which have been most severely damaged by modern erosion are not necessarily associated with the greatest flood plain damage by accelerated sedimentation. Permanent damage to bottom lands often occurs if the upland removals are sand, gravel, or coarser grained sediment. Some of this material is deposited in the stream channel, thereby reducing the channel capacity. The result is a rise in the stream water level and the water table within the alluvial soils that comprise the contiguous bottom lands. This process in its ultimate phases causes swamping of once productive bottom lands. Another type of damage by coarse erosional debris occurs where splays are deposited on bottom lands, or fertile soils are scoured, during floods.

Although the coarser erosional debris is responsible for the greater portion of the permanent land damage, the finer materials cause serious damage of a different nature. Forage plants are rendered unpalatable, temporarily, by deposition of fine material on their foliage. High turbidities, the result of fine material in suspension, increase filtration costs of municipal water supplies. The latter may also be harmful to fish or other aquatic life.

Sheet Erosion

In areas where the original surface layer of the upland soils is fine grained, such as the silt loams and loams, sheet erosion may have caused damage to upland fields; but that portion of the topsoil removals, which is later deposited on alluvial lands, may be as fertile as the soil on which it is deposited. In areas where the surface soil is high in sand content, rapid removal by sheet erosion is likely to be followed by stream channel fill, if channel characteristics are favorable to aggradation, or deposition of sand on fertile flood plain soils.

According to an estimate based on soil surveys, 50 percent of the Piedmont Plateau portion of the watershed now has a clay loam or clay surface soil, as the result of accelerated erosion. These soils under original conditions are believed to have had a sandy loam topsoil, averaging 6 to 8 inches in depth, underlain by a clay subsoil averaging 24 to 30 inches in depth.

The present area of sandy loams of the Cecil and associated series, including the Appling, Durham, Louisburg, and Madison, comprises 48 percent of the Piedmont Plateau part of the watershed. A large portion of these soils are not stabilized, and sheet erosion contributes a large aggregate volume of sand from these areas.

Gully Erosion

Deep gullies affect the areas shown in Table A-2. The most severely gullied portions are in the Piedmont Plateau. Here, in those areas where the Cecil or closely related soils are developed, are the sites of the most serious gullying. These soils have a subsoil underlain by quartz-rich rocks which are weathered and disintegrated to a depth of 25-50 feet or more. The gullies tend to be V-shaped until the resistant clay subsoil horizon has been penetrated. As soon as the gullies have been eroded to the depth of the loose and friable parent material, erosion

is much more rapid. The subsoil horizon is undermined and the gully progressively deepened, broadened, and advanced headward. Large volumes of sterile sand and gravel are removed from gullies particularly after heavy seasonal rains during summer and fall.

Roadway and Railway

Roadway and railway cuts, fills, and drainageways which have not been stabilized constitute another and very important source of erosional debris. This is particularly true of unimproved roads in the Piedmont Plateau and Foothills. Here roadside cuts, fills, and drainageways are generally unprotected and seriously eroded. Some abandoned road sites have been reduced to one large gully at the site of the old roadway.

CLASSIFICATION OF WOODLAND HYDROLOGIC CONDITIONS

Woodlands were classified as good, medium, and poor consistent with the three infiltration rates adopted for hydrologic evaluation. For this classification, field data were obtained on about 100 individual locations, distributed as evenly as possible through the three sample watersheds. Pertinent factors of soil, cover, and use were taken into consideration.

For an estimate of present conditions, the field data were first summarized by soil textural groups and then expanded to the total forest area for each group in each sample watershed. The results are shown in Tables A-3, A-4, and A-5.

In calculating the acreage of the three hydrologic conditions in the future, it was necessary to consider how the recommended remedial measures will modify or eliminate the factors responsible for the present unsatisfactory conditions.

Chief among these factors is fire. Protection against forest fires will be provided for all the woodland in the watershed, regardless of ownership. The object is to limit the average annual area burned to 0.50 percent. The percent of burn on National Forest lands will usually be much less than the allowable limit.

In addition to fire, grazing and destructive timber cutting must be considered in appraising future hydrologic conditions. Separately and in moderation these practices may do no more than temporary damage; but they usually go hand in hand and, in combination, they generally greatly impair watershed values.

On the National Forests, where grazing and cutting are regulated and fire protection of a high order is provided, future hydrologic conditions are expected to be somewhat better than elsewhere in the watershed. Except for a limited burned acreage, which will occur even under the best of protection, the National Forest lands will be in good condition. Of the remaining burned areas some are expected to be in fair or "medium" and some in poor condition. This is because fires tend to recur in certain localities more than in others. On such areas, estimated at almost half of the total residual burned area, the repeated fires do relatively great damage. The remaining areas of annual burn come from scattered fires which recur less often; from these the site will recover in a relatively short period, estimated at 10 years.

In the following table are shown the future acreages of woodland expected to be in good, medium, and poor hydrologic condition. For the watershed as a whole, about 3,448,146 acres of woodland should be in good hydrologic condition (81 percent of the woodland); about 503,634 acres should be in medium condition; and 296,759 acres in poor condition.

SUMMARY OF FUTURE HYDROLOGIC CONDITIONS OF WOODLAND
IN SAVANNAH WATERSHED

Physical Land Unit	Total Area Woodland	Future Hydrologic Condition		
		Good	Medium	Poor
	- - - - - - - - -	- - Acres - -	- - - - - -	- - - -
Mountain-Foothills	702,356	627,463	49,926	24,967
Percent of Unit		89	7	4
Piedmont Plateau	1,999,051	1,683,549	193,794	121,708
Percent of Unit		84	10	6
Coastal Plain	1,547,132	1,137,134	259,914	150,084
Percent of Unit		73	17	10
Total	4,248,539	3,448,146	503,634	296,759
Percent of Watershed		81	12	7

PRESENT LAND USE

Approximately 60 percent of the Savannah River Watershed is in woodland, 22 percent in cropland, 6 percent pasture, 7 percent idle, and 5 percent miscellaneous. Sixty-one percent of the watershed is in farms and 39 percent is not in farms. The non-farm land is chiefly woodland but includes urban areas, roadways and railroads.

Woodland makes up about 42 percent of the farm acreage. Thirty-six percent of the land in farms is in cropland, 8 percent is cropland idle, 3 percent is abandoned idle, 10 percent is in pasture, and 1 percent is occupied by farm sites. Cotton and corn are the principal row crops. Oats and wheat are the principal small grain crops, in that order, and together occupy three-fourths of the small grain acreage. In the Mountains, rye occupies the largest small grain acreage. Pastures are generally overgrazed and badly in need of improvement. Most of the cultivated area is without cover crop protection during the winter months. Erosion of these unprotected fields adds to the runoff and sedimentation problem.

CLIMATE

The chief factors that control the climate in the Savannah River Watershed are its proximity to the Atlantic Ocean, its latitude and altitude. The geographical position of the watershed, well

south in the Temperate Zone, and its proximity to large bodies of semi-tropical water naturally indicate a warm moist climate. While this is true in the Coastal Plain and Piedmont Plateau, the higher altitudes of the Mountain-Foothills have a rather marked modifying effect on the climate there.

Average monthly temperatures vary from approximately 40° during January and 75° during July in the Blue Ridge Mountains, to 50° in January and 80° in July in the Coastal Plain. The maximum temperature recorded at Augusta, Georgia, is 106° and the minimum 3°. The average length of the growing season varies from 270 days in the lower Coastal Plain to 190 days in the Mountains.

The average annual snowfall in the mountain section is about 3.5 inches, unmelted, decreasing to about 1 inch at the fall line. Individual snowfalls rarely last over a day or two. Snow has fallen in the Mountain section to a depth of about 24 inches and to maximum depths of from 8 to 18 inches in the Piedmont Plateau. Snow is seldom if ever an important contributing factor to flood flows in the Savannah basin.

In the Mountain-Foothills, the influence of altitude on rainfall is very pronounced. The topography is such that the moist winds from the Atlantic Ocean drawn from the south or southeast by the passage of barometric depressions over the Great Lakes region or Ohio Valley, are forced upward by the mountain slopes and excessive rainfall is caused by mechanical cooling. The mean annual precipitation varies from 82 inches at Highland, N. C., to a low of 43 inches at Lisbon, Georgia, at the mouth of the Broad River. It then increases as the coast is approached to 48 inches at Savannah, Georgia.

Flood producing storms have occurred every month during the year, although the greatest number is grouped in the first four months. The majority of these occurred in February and March. A secondary storm grouping occurs within the months of August, September, and October. While storms of this period are not nearly as numerous as those occurring in the first part of the year, nevertheless, of the 4 largest floods on record 3 belong to the latter period. These often result from storms associated with West Indian hurricanes. The general effect of these storms is widespread but spotty. High stages invariably occur on main streams with disastrous floods on many of the tributaries. Because of the season of their occurrence, they produce the most extensive crop damage.

GROUND WATER

Mountain-Foothills and Piedmont Plateau

The Mountain-Foothills and Piedmont Plateau are underlain by Pre-Cambrian rocks with later intrusives. These are largely gneiss, schist and granites which yield ground water from the weathered upper portion, and from joints which occur within a few hundred

feet of the surface. Shallow dug wells in the weathered surface zone and springs are the source of small domestic and stock water supplies. Deeper drilled wells and larger springs supply water for small municipalities and for industry. There are no records of the total amount of ground water used on farms. Ground water consumption by municipalities and industry in the Mountain-Foothills and Piedmont Plateau amount to approximately 550,000,000 gallons annually. In contrast, 1,900,000,000 gallons are consumed annually by municipalities and industries which obtain their supplies from surface water.

Coastal Plain

In the Coastal Plain, ground water is the chief source of water supply in both rural and urban areas. A large part of the rural water supplies is obtained from shallow dug wells. The most prolific artesian aquifers are limestones or Eocene and Oligocene age. The area of recharge of these formations is at their area of outcrop just below the fall zone. The amount of artesian water pumped from wells owned by the City of Savannah alone is about 5,000,000,000 gallons annually. In addition, privately-owned wells in the Savannah area pump approximately twice this amount for industrial and business uses.

The greatest discharge of artesian water is in the Savannah, Georgia area. These high discharge rates, due chiefly to heavy pumpage but partly to wastage from flowing wells from the same formations, account for the pronounced lowering of piezometric levels in the Savannah, Georgia area.

Little consideration and no detailed study has been made in this area toward the end of benefiting ground water supply by increasing the influent seepage rate. In some other sections of the country, there is direct evidence to show that ground water supplies have been increased by conservation practices. This problem of increasing ground water by conservation practices over the intake area merits further consideration. In the Piedmont Plateau and Mountain-Foothills, the infiltration surfaces through which influent seepage occurs are in the immediate vicinity of the wells or springs from which the ground water supply is derived. In the Coastal Plain this is generally true of the more shallow wells. However, the recharge areas for the artesian aquifers, which are the chief source of water supply for the Savannah, Georgia area, are the outcrops of these water bearing formations. These intake areas include hundreds of square miles of land surface in the northern portion of the Coastal Plain at elevations generally 100-500 feet above sea level. Between the intake or recharge area and the Savannah, Georgia discharge area, the artesian aquifer is capped by an impervious formation. The top of the water bearing formation in the Savannah, Georgia area is about 300 feet below sea level. The original artesian pressure here was sufficient to cause most of the wells to flow naturally, but water levels have declined 80-100 feet in the area. Practically all artesian water in the Savannah area is now obtained by pumping.

Table A-1

DISTRIBUTION OF
...ING PRESENT LAND USE BY

	Piedmont Plateau				Entire Watershed				
	Land Use (Acres)				Land Use (Acres)				
...nd	Woodland	Idleland	Pa...	Sub-Total	Cropland	Woodland	Idleland	Pasture	Sub-Total
...7	77,873	5,653	2...	130,375	143,563	103,750	9,022	43,194	299,529
...7	125,085	11,634	2...	202,678	382,096	195,563	17,297	34,660	629,616
...2	34,943	557	9...	177,026	19,962	156,816	9,165	44,954	230,897
	--	--		28,878	19,469	7,020	1,636	1,026	29,151
...8	369,415	76,251	84...	146,753	530,562	482,562	96,115	96,571	1,205,810
...5	5,373	961	2...	309,931	26,401	254,679	17,466	24,663	323,209
	--	--		264,300	100,420	125,065	33,744	5,071	264,300
...3	378,547	50,376	41...	124,515	111,015	522,058	63,691	49,666	746,430
	--	--		21,913	182	45	21,686	--	21,913
	--	--		64,935	14,898	37,918	11,800	319	64,935
...0	39,756	2,527	15...	515,367	5,084	550,964	6,273	18,163	580,484
...7	462	83		--	57	462	83	125	727
...1	261,501	16,666	22...	174,122	62,937	522,932	30,456	26,434	642,759
...5	618,129	106,987	48...	48,832	63,871	1,119,314	133,131	65,567	1,381,883
...1	119	12		--	1	903	2,889	162	3,955
...6	1,911,208	271,707	284...	2,209,625	1,480,518	4,080,051	454,454	410,575	6,425,598
				105,545					344,962
				2,315,170					6,770,560

...lity to erosion, by wate...
...er, such as that produce...
...dingly unfavorable soil ...y high density (imperviousness),
...effective depth, etc.
...adways and railways.
...ea).

Table A-1

Table A-1

DISTRIBUTION OF LAND IN THE SAVANNAH RIVER WATERSHED
SHOWING PRESENT LAND USE BY CAPABILITY CLASSES WITHIN EACH PHYSICAL LAND UNIT

Land Capability		Mountain-Foothills Land Use (Acres)					Piedmont Plateau Land Use (Acres)					Coastal Plain Land Use (Acres)					Entire Watershed Land Use (Acres)				
Class	Subclass 1/	Cropland	Woodland	Idleland	Pasture	Sub-Total	Cropland	Woodland	Idleland	Pasture	Sub-Total	Cropland	Woodland	Idleland	Pasture	Sub-Total	Cropland	Woodland	Idleland	Pasture	Sub-Total
I		13,868	5,072	1,601	5,137	25,678	31,017	77,873	5,653	28,933	143,476	98,678	20,805	1,768	9,124	130,375	143,563	103,750	9,022	43,194	299,529
II	e	10,826	15,478	2,595	2,460	31,359	230,057	125,085	11,654	28,803	395,579	141,213	55,000	3,068	3.397	202,678	382,096	195,563	17,297	34,600	629,616
	w	1,343	163	207	219	1,932	6,692	34,943	557	9,747	51,939	11,927	121,710	8,401	34,988	177,026	19,962	156,816	9,165	44,954	230,897
	s	121	64	14	74	273	--	--	--	--	--	19,348	6,956	1,622	952	28,878	19,469	7,020	1,636	1,026	29,151
III	e	42,619	42,772	8,146	8,233	101,770	427,448	369,415	76,251	84,173	957,287	60,495	70,375	11,718	4,165	146,753	530,562	482,562	96,115	96,571	1,205,810
	w	--	309	--	20	329	3,725	5,378	961	2,885	12,949	22,676	248,992	16,505	21,758	309,931	26,401	254,679	17,466	24,663	323,209
	s	--	--	--	--	--	--	--	--	--	--	100,420	125,065	33,744	5,071	264,300	100,420	125,065	33,744	5,071	264,300
IV	e	19,156	45,699	6,873	7,285	79,013	72,143	378,547	50,376	41,836	542,902	19,716	97,812	6,442	545	124,515	111,015	522,058	63,691	49,666	740,430
	w	--	--	--	--	--	--	--	--	--	--	182	45	21,686	--	21,913	182	45	21,686	--	21,913
	s	--	--	--	--	--	--	--	--	--	--	14,898	37,918	11,800	319	64,935	14,898	37,918	11,800	319	64,935
V	w	436	1,193	421	945	2,995	3,860	39,756	2,527	15,979	62,122	788	510,015	3,325	1,239	515,367	5,084	550,964	6,273	16,103	580,484
	s	--	--	--	--	--	57	462	83	125	727	--	--	--	--	--	57	462	83	125	727
VI	e	6,238	111,919	1,034	2,663	121,854	45,641	261,501	16,666	22,975	346,783	11,058	149,512	12,756	796	174,122	62,937	522,932	30,456	26,434	642,759
VII	e	11,088	466,832	16,507	15,907	510,334	48,935	618,129	106,987	48,666	822,717	3,848	34,353	9,637	994	48,832	63,871	1,119,314	133,131	65,567	1,381,683
VIII	s	--	784	2,877	148	3,809	1	119	12	14	146	--	--	--	--	--	1	903	2,889	162	3,955
Sub-Total		105,695	690,285	40,275	43,091	879,346	869,576	1,911,208	271,707	284,136	3,336,627	505,247	1,478,558	142,472	83,348	2,209,625	1,480,518	4,080,051	454,454	410,575	6,425,598
Misc. 2/						32,124					207,293 3/					105,545					344,962
Total Area						911,470					3,543,920					2,315,170					6,770,560

1/ Definition of subclasses: e - Dominant limitation is susceptibility to erosion, by water.
w - Dominant limitation is excess water, such as that produced by seepage, high water table, or floods.
s - Dominant limitation is an outstandingly unfavorable soil characteristic, such as low moisture capacity, very high density (imperviousness), excess gravel or stones, shallow effective depth, etc.

2/ Includes farm homesites, urban areas, lakes, stream channels, roadways and railways.

3/ Includes Clark Hill Reservoir as in place (78,500 acres water area).

Table A-2

DISTRIBUTION OF DEEP GULLIES IN SAVANNAH RIVER WATERSHED

Physical Land Units	Less Than 3 Per Acre	More Than 3 Per Acre	More Than 75 Percent Gullied	Total Area Affected	Total Land Area
Mountain-Foothills	13,956 acs.	17,051 acs.	168 acs.	31,175 acs.	911,470 acs.
Piedmont Plateau	587,195 acs.	366,340 acs.	19,494 acs.	973,029 acs.	3,543,920 acs.
Coastal Plain	72,252 acs.	1,418 acs.	6,430 acs.	80,100 acs.	2,315,170 acs.
Total	673,403 acs.	384,809 acs.	26,092 acs.	1,084,304 acs.	6,770,560 acs.

Table A-3

WOODLAND AREAS IN THE KEOWEE RIVER WATERSHED, S. C. AND N. C.

Soil Group	Texture	Present Hydrologic Condition (Acres)			
		Good	Medium	Poor	Total
Fine sandy loams 1/	61% sand 28% silt 11% clay	82	330	1,178	1,590
Loams	45% sand 40% silt 15% clay	8,457	33,829	120,736	163,022
Fine sandy loams 2/	69% sand 20% silt 11% clay	3,069	12,273	43,801	59,143
Clay loams	40% sand 35% silt 25% clay	--	--	8,405	8,405
Total all groups		11,608	46,432	174,120	232,160
Percentages		5	20	75	100

1/ Bottomland soils.
2/ Upland soils.

Table A-4

WOODLAND AREAS IN THE BROAD RIVER WATERSHED, GEORGIA

Soil Group	Texture	Present Hydrologic Condition (Acres)			
		Good	Medium	Poor	Total
Fine sandy loams	66% sand 24% silt 10% clay	1,121	9,039	24,873	35,033
Sandy loams	75% sand 15% silt 10% clay	7,202	58,063	159,786	225,051
Clay loams and clays	46% sand 24% silt 30% clay	--	--	72,597	72,597
Silt loams and silty clay loams	22% sand 58% silt 20% clay	43	348	1,391	1,782
Clay loams	45% sand 31% silt 24% clay	311	2,487	9,949	12,747
Total all groups		8,677	69,937	268,596	347,210
Percentages		3	20	77	100

Table A-5

WOODLAND AREAS IN THE LITTLE RIVER WATERSHED, S. C.

Soil Group	Texture	Present Hydrologic Condition (Acres)			
		Good	Medium	Poor	Total
Fine sandy loams	66% sand 24% silt 10% clay	658	1,324	5,946	7,928
Sandy loams	75% sand 15% silt 10% clay	2,347	4,722	21,208	28,277
Clay loams and clays	46% sand 24% silt 30% clay	--	--	22,019	22,019
Silt loams and silty clay loams	22% sand 58% silt 20% clay	37	73	624	734
Clay loams	45% sand 31% silt 24% clay	331	661	5,620	6,612
Total all groups		3,373	6,780	55,417	65,570
Percentages		5	10	85	100

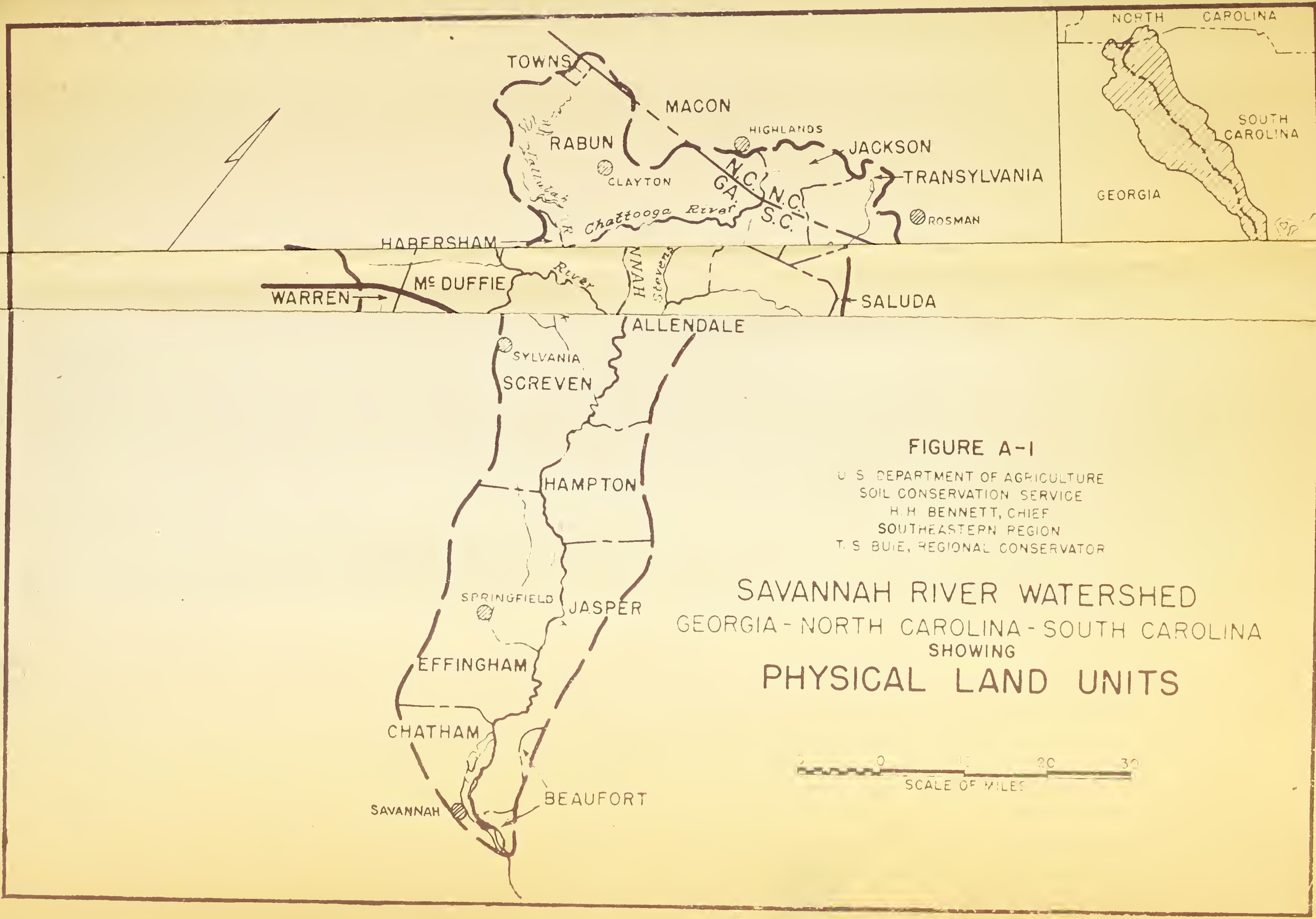

FIGURE A-1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL CONSERVATOR

SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA
SHOWING
PHYSICAL LAND UNITS

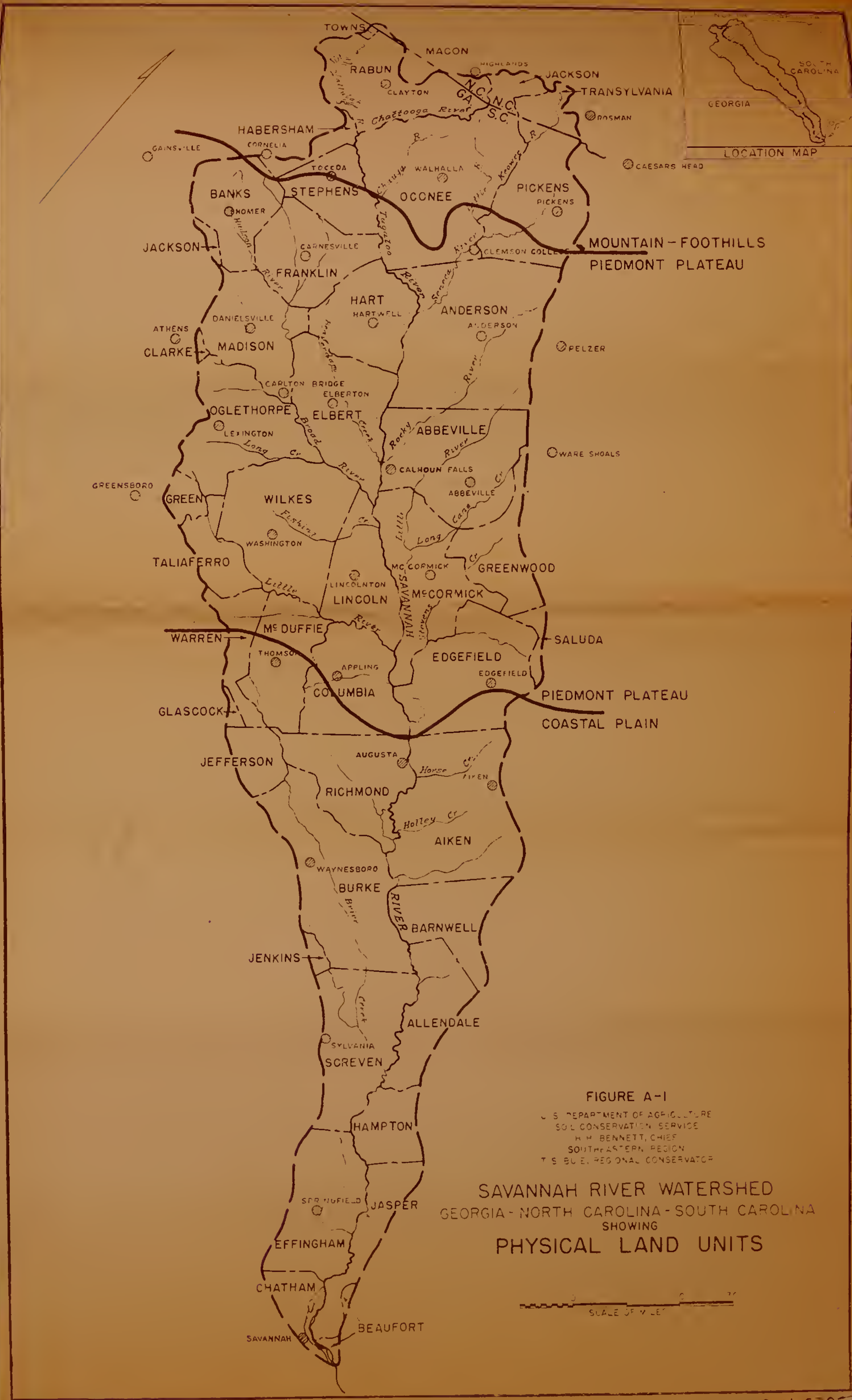

FIGURE A-1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL CONSERVATOR

SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA
SHOWING
PHYSICAL LAND UNITS

2-N-6705

APPENDIX B
LAND AND WATER ECONOMY
SAVANNAH RIVER WATERSHED

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LAND AND WATER ECONOMY

Area and Population

Of the 45 counties in the watershed that will be directly affected by the recommended program, four are in North Carolina, 14 in South Carolina, and 27 in Georgia. Ten of the Georgia and two of the South Carolina counties lie entirely within the Savannah River Watershed. All four North Carolina, 12 of the South Carolina, and 17 of the Georgia counties are only partially within the watershed.

The total land area of the watershed is approximately 6,770,560 acres, or 10,579 square miles. Approximately 640,000 people were living in the watershed at the time of the 1940 census--5,000 in North Carolina, 243,000 in South Carolina, and 392,000 in Georgia. The larger population in Georgia is due primarily to the concentration of people in Savannah and Augusta, the two largest cities in the watershed. On a proportionate basis, North Carolina has two percent of the total watershed area and one percent of the population; South Carolina has 43 percent of the total area and 38 percent of the population; while Georgia has 55 percent of the total area and 61 percent of the population.

In 1940 approximately 64 percent of the population (409,600) was rural. At the time of the 1945 Census of Agriculture, 205,600 people lived on farms. There was an increase of about 12 percent in the total population of the watershed between 1930 and 1940. In the meantime, the relation between rural and urban populations changed from 32 percent urban in 1930 to 36 percent urban in 1940.

Two urban centers had populations exceeding 50,000 people in 1940. They are Savannah and Augusta, Georgia, with populations of approximately 96,000 and 66,000, respectively. Both of these cities are in the Coastal Plain area and both of them are on the main stem of the Savannah River. The Savannah River was the main inland artery of commerce of the watershed during early settlement, thus establishing Savannah and Augusta as the two oldest urban centers.

The density of population in other parts of the watershed away from the major streams has increased rapidly in recent years. Anderson and Greenwood, South Carolina, with a 1940 population of approximately 19,400 and 13,000 people, respectively, are still the only large urban centers not located on the main stream. Greenwood, South Carolina, is not completely within the watershed. Three other urban centers, Elberton and Toccoa, Georgia, and Aiken, South Carolina, are in the 5,000 to 10,000 population group, and nine others are in the 2,500 to 5,000 class.

Agricultural Resources

Agriculture accounts for the major portion of the occupational activity, with cotton still the predominating cash crop for the area as a whole. Due to the wide variations in topography, soils, and climate, and the corresponding differences in types and systems of farming the three following major areas are considered separately.

Mountain-Foothills Area

Approximately 911,470 acres (over 1,424 square miles) are in the Mountain-Foothills area. About 401,000 acres, or 44 percent, are in farms. The greater portion of the non-farm land is public and private non-farm woodland.

The farms in the Mountain part of this area are rough and average about 50 acres per farm. About 60 percent of the average farm is in farm woodland, 16 percent in row crops, 14 percent in hay and pasture, two percent in other annual crops, and eight percent is idle or abandoned land. These farms are principally owner-operated, subsistence type, with fruit and vegetables and a small amount of livestock and poultry providing some cash income.

The four major crops in this part of the area in order of gross value at 1947 prices are corn, vegetable crops (including home use), hay crops, and fruit crops (principally apples). No cotton is grown. Corn accounts for over 40 percent of the gross value of all crops. Most of the corn is produced in the bottom land areas within the flood plains of the tributary streams and is subject to flood damages. Less frequent flood damages occur here than in the other areas of the watershed.

The farms in the Foothills part of this area average about 70 acres in size. The four most important crops based on gross value at 1947 prices are cotton, corn, vegetable crops (including home use), and hay and seed crops. Cotton accounts for about 40 percent of the total gross value of all crops, and corn accounts for an additional 20 percent. Corn is the principal crop grown in the flood plains of this part of the area, but due to the comparatively limited areas of bottom land, most of this crop is grown on upland. Over 45 percent of the farm land in the Foothills part of the Mountain-Foothills area is in woods, 20 percent in clean cultivated row crops, nearly 15 percent in hay and pasture, eight percent in other annual crops, and about 12 percent is idle or abandoned land. Small grains assume more importance here than in the Mountains.

Piedmont Plateau

The Piedmont Plateau embraces the largest portion (52 percent) of the Savannah River Watershed. This area includes 3,543,920 acres (over 5,537 square miles) of which 2,430,220 acres (69 percent) are in farms.

The average size farm is about 86 acres, of which 40 percent is in woods, 20 percent in clean cultivated row crops, 17 percent in pasture and hay crops, 12 percent in small grains, and 11 percent is idle and abandoned land. The cultivated land ranges from poor to excellent for crop production.

Cotton is by far the most important cash crop in the area. At the 1947 price level and based on gross value, the four most important crops in this area are cotton, small grain, corn, and hay and seed crops. Cotton accounts for 56 percent of the total gross value of all crops, small grain accounts for an additional 14 percent, and corn for 11 percent -- a total of over 80 percent for cotton and grain crops. Livestock is becoming important in this area, with the trend indicating more importance in the future. Some of the grain produced in this area is now marketed through livestock.

Row crops in the flood plains of this area have been generally abandoned due to the flood hazard and to swamping. Hay and pasture are predominant in the openland flood plain areas.

Coastal Plain

The Coastal Plain includes 34 percent or approximately 2,313,170 acres (over 3,617 square miles) of the watershed. Farms occupy 56 percent, or 1,299,210 acres, of this area.

The farms are relatively large, averaging about 116 acres. The present major uses of farm land in this area are: 43 percent in woods, 31 percent in clean cultivated row crops, nine percent in hay and pasture, six percent in small grains, and 11 percent in idle and abandoned land.

Cotton is the most important cash crop in this area, representing 50 percent of the gross value of all crops. Peanuts are the next largest cash crop, but represent only eight percent of the total. The four most important crops in this area based on gross value at 1947 prices are cotton, corn, vegetable crops (including home use), and peanuts. This area is deficient in the acreage of winter legumes grown for soil building and in the use of other close growing legume crops in rotations with the clean tilled crops.

A progressive livestock industry development has been retarded in some parts of this area by free range conditions. This contributes to the use of poor grade livestock and hampers the development of improved pastures and winter cover crops.

Nearly all of the flood plain land along the tributary streams is swamped, with swamp hardwoods the principal product.

Industry

Savannah, Georgia, the largest city, is located 17 miles from the mouth of the Savannah River. It is important as a railroad and commercial center as well as a seaport from which cotton, lumber, and naval stores are exported in large quantities. The principal industries are lumber, cottonseed and peanut processing, fertilizer, pulp and paper mills, and railroad shops.

Augusta, Georgia, is the junction point of several railroads. It has been a textile manufacturing center for approximately a century. Other important industries include cotton warehouses, cottonseed oil and peanut mills, foundries, fertilizer plants, lumber mills, and brick and tile plants.

Textile mills are numerous throughout the Piedmont Plateau, but the factories are decentralized. There are many small mill towns throughout the Piedmont section. Anderson, South Carolina, is the largest of these. The city of Aiken, South Carolina, located in the upper Coastal Plain, with a population of 6,168 in 1940, is a well-known winter resort.

Mining and quarrying include such minerals as kaolin, fuller's earth, clay, granite, graphite and some gold.

Farm Ownership

In 1945, 46 percent of the farm operators were owners. Farm ownership is increasing. The percentage of operators owning farms increased over five percent between 1940 and 1945.

Farm tenancy varies widely from one area of the watershed to another. In 1945 tenancy in the Mountain part of the Mountain-Foothills area was less than 22 percent while the greatest tenancy (over 59 percent) occurred in the Piedmont Plateau. The average tenancy for the Coastal Plain area was about 53 percent. The general decrease in tenancy from 1940 to 1945 occurred in all the areas. The decrease was greatest in the Mountain-Foothills area. The decrease in tenancy in the Coastal Plain area was less than in the other areas.

Woodland Ownership

Woodland ownership was considered in developing the woodland phase of the remedial program for flood control purposes. Publicly owned woodlands total 461,354 acres. The summary contained in the section dealing with public land areas gives a more detailed breakdown of this acreage. The privately owned woodlands consist of 3,631,500 acres of farm and non-farm woodlands.

Public Land Areas

Several parcels of land (total of 495,378 acres) are publicly owned. Most of these are woodland. The following summary shows the type of public ownership and the area in woodland.

Public Land Areas, Savannah River Watershed

	National Forest	Other Federal	County and State	Total
	---------- Acres ----------			
Total land area	391,290	95,748 1/	8,340	495,378
Forested area	391,290	61,724	8,340	461,354

State and County Lands

Alexander H. Stephens Memorial Park in Taliaferro County, Georgia, consists of 1,175 acres of which 238 acres are within the city limits of Crawfordville, Georgia. Oconee State Park in Oconee County, South Carolina, consists of 1,165 acres in the northern part of the watershed near the North Carolina state line.

An estimated 4,000 acres of tax delinquent lands in the Fall Line Hills of Aiken County, South Carolina, have reverted to the state. About two-thirds of this area is in the Savannah River Watershed, but is not in contiguous tracts. The small isolated areas affect the possibility of utilizing these areas as State Parks.

Federal Lands

Of the 1,034,911 acres within the boundaries of national forests in the watershed, an estimated 391,290 acres have been acquired. This includes a large proportion of the watershed lands contributing to the important hydroelectric developments in the Mountain region. Managed primarily for watershed protection and timber production, these lands have been highly effective in preventing sedimentation and in regulating streamflow. Similar, though perhaps less obvious, services have been performed by the more recently acquired lands in the Piedmont region.

A land utilization project consisting of 27,441 acres in parts of Anderson, Pickens, and Oconee Counties, South Carolina, is leased to Clemson College. This lease began in 1938 and is to continue for 95 years.

Camp Gordon, an Army camp in Richmond County, Georgia, is entirely within the watershed. It contains 55,652 acres, mostly wooded.

1/ Other Federal includes the Land Utilization Project (27,441 acres) leased to Clemson College.

The Savannah River National Wildlife Refuge, 12,655 acres of mostly marsh lands, is located in Chatham County, Georgia, and Jasper County, South Carolina, and lies within the watershed.

Legislative Factors

The states of Georgia, North Carolina, and South Carolina have enacted legislation enabling the organization of soil conservation districts. Districts were actively operating throughout the entire drainage basin in 1949 except for a small portion of Towns County in Georgia, and small portions of Transylvania, Jackson, and Clay Counties in North Carolina. Farmers in part of the area not in organized soil conservation districts have submitted petitions for the organization of districts.

The states of Georgia, North Carolina, and South Carolina also have laws for the organization of drainage districts. There are about 25 drainage enterprises in the Savannah River Watershed in South Carolina and Georgia. These districts are concentrated in the Piedmont Plateau. These works of improvement represent a capital investment of approximately $1,000,000, and affect an area of some 68,000 acres.

The majority of these districts have been inactive during recent years. The experience in the flood control operation program is that the installation of channel improvement for flood control stimulates renewed interest in drainage.

The Weeks Act of 1911 and the Clarke-McNary Act of 1924 provide for Federal acquisition for watershed protection or timber production provided the states consent to such acquisition. The states of Georgia, North Carolina, and South Carolina have passed enabling acts consenting to Federal acquisition.1/ However, the Flood Control Act of 1944 requires specific state enabling legislation for acquisition of lands for flood control purposes. Need for such legislation has not developed as yet in these states.

The Fulmer Act of 1935 provided for state ownership of forest lands acquired with Federal funds. However, no funds have ever been appropriated by Congress for this purpose, and the Act is generally regarded as obsolete.

Procedures are established in Georgia, North Carolina, and South Carolina for acquiring title to tax delinquent lands by counties that may in turn transfer such lands that the Department of Conservation and Development deems useful in establishing state forests.

The Clarke-McNary Act of 1924 provides for Federal-State cooperation on a fund matching basis in forest fire control and tree planting.

1/ Purchase in Georgia is limited to the following counties: All those counties in the northern and central portions of the state south to and including the following counties: Stewart, Webster, Marion, Taylor, Upson, Monroe, Jones, Putnam, Greene, Taliaferro, Wilkes, Jasper, Elbert, Warren, Hancock, Oglethorpe, Dodge, Treutlen, Laurens, Butts, and Richmond, and in the Okefenokee Swamp. In South Carolina, enabling legislation was amended in 1948 to limit national forest acquisition to lands within the boundaries of existing national-forest units, and, insofar as practical, to lands unsuited or little suited for agriculture.

The Norris-Doxey Farm Forestry Act of 1937 provides for Federal contributions to the states for technical assistance to small owners in woodland management, including advice and guidance in the planting and silvicultural treatment, woodland protection; and the harvesting, utilization, and marketing of forest products. These and related services to forest owners and operators will be provided under recently enacted legislation (Public Law 729, 81st Congress, 2nd Session) which supersedes the Norris-Doxey Act, effective June 30, 1951.

The states of Georgia, North Carolina, and South Carolina are actively cooperating with the Federal Government in the activities authorized by the above mentioned laws. This cooperation assures an excellent basis for expediting the application of any authorized watershed treatment program.

APPENDIX C

HYDROLOGY

SAVANNAH RIVER WATERSHED

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PROCEDURES FOR CALCULATING FLOOD REDUCTIONS

Hydrologic investigations were conducted to determine flood reductions which might be expected as a result of the recommended program. To simplify the determination of present and future damages and benefits which would accrue from the program, the evaluation was undertaken on (a) tributaries and (b) reaches of the main stream of the Savannah River system. Procedures followed in connection with this phase of the survey are discussed in that order.

Basic data, computations, analyses, and detailed information used in developing the hydrology appendix are available in the files of the Soil Conservation Service Washington office or the Southeastern Regional office.

TRIBUTARIES

The Savannah River drainage area was divided into Physical Land Units which, under similar cover and treatment, produce fairly uniform runoff, sediment, and deterioration of soil resources. Sample tributaries were selected to represent these Physical Land Units. The location of the Physical Land Units and of the sample stream drainage areas selected to represent each is shown in Figure C-1.

Two sample tributaries were selected for the Piedmont Plateau Physical Land Unit because it is the largest and most important of the Physical Land Units, and because no single sample could be found which seemed to adequately represent the whole land unit.

A sample tributary was selected for the Coastal Plain Physical Land Unit. Field investigations revealed that damages in the flood plain of the selected sample tributary were not significant. Consequently, hydrological investigations were not made on the Coastal Plain sample tributary.

Description of Sample Tributaries

1. Keowee River above the gage near Newry, South Carolina, was selected to represent the tributaries in the Mountain-Foothills Physical Land Unit. The drainage area contains 455 square miles and is roughly rectangular in shape (28 miles long and 16 miles wide) with the gage located near the southeast corner. The watershed lies from about 600 feet to about 2,000 feet above sea level. The greater part is above 1,000 feet; the stream profile itself goes to over 1,300 feet above sea level near the headwaters. The lower third of the stream has an average slope of about 5 feet per mile, the middle third about 20 feet per mile, and the upper reaches average from 40 feet per mile in their lower portions to much steeper on some of the upper tributaries.

The gage itself is located in the Piedmont Plateau, but all except a negligible part of the watershed lies in the Mountain-Foothills Physical Land Unit. The topography is moderately rough, corresponding to the usual topography of the Mountain-Foothills. The drainage pattern is approximately fanshaped. Little River, Oconee County, a large tributary entering the Keowee about one mile above the gage, is of similar shape.

2. Broad River above the gage near Bell, Georgia, was selected as one of the tributaries to represent the Piedmont Plateau Physical Land Unit. This is a large sample tributary, the drainage area above the gage containing 1,420 square miles. It is an irregular rectangle, about 60 miles long and with an average width of about 24 miles.

The watershed lies from about 350 feet above sea level (at the gage) to about 1,500 feet for the upper reaches. The greater part is below 1,000 feet, however - the portion above 1,000 feet elevation being mostly in the upper reaches, with a "foothill" type of topography. The lower third of the stream has an average slope of about 2.5 feet per mile, the middle portion a slope of about 6 feet per mile, while the headwater reaches have slope somewhat greater than this; on a few tributaries, considerably greater.

The stream runs irregularly the length of the rectangular drainage area, with tributaries on each side, but the longer ones all entering from the southwest. The drainage pattern is approximately fan-shaped on the upper 40 percent of the drainage area, above the point where the Hudson River and several other streams join to form the main Broad River. Below this point the tributaries enter at widely separated points.

The Broad River sample tributary was used in the analysis to represent the larger tributaries of the Piedmont Plateau, while the smaller tributaries were represented by the Little River (South Carolina) sample tributary.

3. Little River above the gage near Mount Carmel, South Carolina, was selected as the other sample tributary to represent the Piedmont Plateau. The drainage area contains 217 square miles and is roughly oval in shape (30 miles long by about 10 miles at the widest part) with the gage at the southern end. The watershed lies from about 330 feet (at the gage) to about 900 feet above sea level, the average elevation of the greater portion being about 600 feet. The lower half of the stream has an average slope of about 7 feet per mile; above this the average slope is about 13 feet per mile until the headwaters are reached, where the slope is greater on most of the tributaries.

The stream runs approximately through the middle of the drainage area for its whole length. The tributaries entering it are comparatively small and are of about equal length and number on each side.

Availability of Precipitation and Stream-Flow Data

Records of daily rainfall from standard U. S. Weather Bureau depth-of-precipitation gages were reasonably plentiful over the watershed and in the immediately adjacent areas. Some of these were of long duration. Athens, Georgia, and Gainesville, Georgia, have records of 70 years or over. Stations used in the analysis of the sample tributaries and having 50 or more years of record are Highlands, North Carolina, Anderson, South Carolina, Calhoun Falls, South Carolina, Clemson College, South Carolina, Carlton Bridge, Georgia, Clayton, Georgia, Toccoa, Georgia, and Washington, Georgia. Walhalla, South Carolina, had 48 years. The "Horton-Thiessen" weights for each of the sample tributaries, for as long a period as required for the analysis, are shown in Table C-1. The periods of record of the rain gage stations within or close to the watershed, starting with the year 1926, are shown in Figure C-2.

Rainfall intensity-of-precipitation records were available at some Weather Bureau recording stations in the watershed. However, records for Atlanta, Georgia, have been analyzed for use in previous surveys and these were used where intensity records were needed, as Atlanta is reasonably near the watershed and is in the same general climatic area. (See "Development of Infiltration Data.")

Stream-flow records were reasonably numerous both on the main streams and on the tributaries. Records on the selected sample tributaries were of sufficient duration to use without requiring extension by the use of data gathered from other streams.

Outline of the Procedure for Evaluating the Recommended Program

The major phases of the procedure used to evaluate the effect of the recommended program on each sample tributary and to expand these data to the Physical Land Units are briefly outlined below.

1. Rainfall P versus runoff Y relations were developed for each sample tributary using actual stream-flow and precipitation records.

2. An evaluation series of floods was developed for each sample tributary.

3. Infiltration data used in this survey were derived by a simplified formula method. Local soil, cover, and hydrologic conditions were taken into account by the use of special coefficients in a general formula. The major steps used in the application of the formula are:

  a. An analysis was used of the best available rainfall record from a recording gage (intensity of precipitation data) typical so far as possible of the whole watershed. This included computing various characteristics of a group of average "design" storms from 1.50 inches to 6.00 inches total precipitation.

b. The soils in the watershed were classified as to texture and the area of each determined by Physical Land Units.

c. Cover conditions were classified in accordance with the classification set up by the coefficients used in the formula. This in combination with the soil classification of (b) gives the evaluation classes used in this phase of the investigation.

d. The area of each evaluation class in each sample tributary was determined and listed. This was done for both present conditions and future conditions (after land treatment measures have been applied).

e. An index (Θ) was computed for each evaluation class in each sample tributary using the infiltration formula and the average rainfall versus runoff relation of 1 above. This index (Θ), measured in inches per hour, indicates the infiltration rate and was adjusted to conform with the measured P versus Y relation.

f. Using these values of Θ and the areas of each evaluation class (both present and future), computed storm runoffs (P_c) were determined for each evaluation class and for the whole sample tributary for each of the average storms. This gave P_c versus P relations for the sample tributary for both present and future.

4. Studies were made of all floods in the evaluation series to determine the reduction in peak flows that would result in the Mountain-Foothills and Piedmont Plateau Physical Land Units from channel improvements.

5. Peak stages for future conditions (after both channel improvement and recommended land use measures are applied) were determined for each flood in the evaluation series. See "Effect of the Recommended Program on Flood Reductions."

6. The areas inundated by each flood: (1) under present conditions, and (2) after channel improvement and land treatment measures combined, were determined from the peak stages of 5 above. With this information, it was possible to estimate the flood damages over the period covered by the evaluation series of floods.

Each of the above-listed steps is explained more fully in the following sections.

PRESENT STORM DISCHARGE

Rainfall versus Runoff Relations

Rainfall versus runoff relations were developed for each sample tributary using available stream-flow and precipitation data. Depth of rainfall (P) over the watershed was computed using the Horton-Thiessen method of distributing recorded precipitation. (See Table C-1 for the weights used for each sample tributary.) Total discharge was computed using the discharge hydrographs for the storm periods, plotted from stream-flow data. Ground-water inflow into the stream was determined by a simplified method based on the ground-water depletion curve. Total discharge during the storm period less ground-water inflow gave the "storm discharge" (Y). These computations were made for each storm occurring in the evaluation series. The results were plotted and an average P versus Y curve was derived for each sample tributary. Seasonal curves were not used, one curve only being drawn for each sample. Past experience with a seasonal breakdown in adjacent watersheds has not been satisfactory. Seasonal differences in the P versus Y relation do appear, but they are neither large enough nor consistent enough to be useful.

Average "Peak Stage versus Discharge" curves were developed for use in determining the stage versus area of inundation relation. Peak stage for each significant storm was plotted against the storm discharge (Y), and an average curve drawn. The average Peak Stage versus Discharge curve for conditions after channel improvement has been made was determined from this curve and from the channel improvement studies. The P versus Y and Peak Stage versus Y curves for Broad River sample tributary are shown in Figures C-3 and C-4.

The Evaluation Series of Floods

1. Keowee River: The actual series of floods recorded at the gage on the Keowee River near Newry, South Carolina, for the 7-5/6 year available record (Dec. 1, 1939, to Sept. 30, 1947) was used as the evaluation series of flood events. During this period of record, 37 definite rises occurred. These were analyzed for the P versus Y relation. However, not all of these caused appreciable out-of-bank flow, which occurs at about 15.0 feet (gage reading) on the Keowee.

2. Broad River: The actual series of floods for the 16-year period of record at the gage on Broad River near Bell, Georgia, was used as the evaluation series of flood events. This period of record covered the periods from November 1926 to July 1932 and August 1937 to October 1947. While interrupted during the years from August 1932 to July 1937, the record gives a good representation of average conditions. It includes the great floods of August 1928, March 1929, September 1929, October 1929 (the maximum of record) and August 1940. It also includes the extreme drought years 1930 and 1931, besides a reasonable number of years with precipitation below normal. For use in the P versus Y relation, 91 storms were analyzed, of which less than half had peaks appreciably above the 15-foot stage which causes inundation. Table C-2 lists the rises causing inundation and flood damages.

3. Little River (South Carolina): The actual series of floods recorded at the gage on the Little River (South Carolina) near Mount Carmel, South Carolina, for the 7-3/4 year available record (January 1, 1940, to September 30, 1947) was used as the evaluation series of flood events. During this period of record, 46 definite rises occurred which were analyzed for the P versus Y relation. Only 28 of these reached a peak of 10.0 feet, while appreciable inundation begins at about an 11-foot stage.

Development of Infiltration Data

The Infiltration Formula - Infiltration data from the entire United States have been collected and analyzed by the Soil Conservation Service Washington office. The result has been condensed into an empirical formula (in two parts) which simplifies the application of the data to actual cases. The formula is:

$$\Theta = C\,[.178 + (S + k)] - .178, \text{ when } S + k > .20,$$
$$\Theta = C\,[.604 + (S + k)] - .604, \text{ when } S + k < .20.$$

The symbols have the following meanings.

The coefficient S was introduced into the formula to measure the effect of soil on the infiltration rate by using the soil texture. (See Soil Classification.)

The coefficient C, introduced into the formula to measure the effect of cover conditions on the runoff, is described with a listing of values under the heading: Cover Conditions; Evaluation Classes.

The watershed coefficient (correction factor) k and the index Θ are explained under the heading: Computation of the Index Θ.

The factor k was determined by a trial and error process. Its purpose is to adjust the computed runoff so that it equals measured runoff for present watershed conditions. The values of Θ, for each evaluation class, were computed using the value of k and the corresponding values of C and S. Those computations were made for present conditions, and it was then assumed that the watershed factor k would remain the same in the future, after the land treatment measures have been applied.

In the sections immediately following, methodology applicable to this survey gives an indication of the computations required before the formula itself can be applied.

Analysis of Intensity of Precipitation Records - As mentioned under "Availability of Precipitation and Stream-Flow Data," records for Atlanta, Georgia, were used in this survey, since Atlanta is reasonably close to the watershed and has a climate typical of the general Savannah River Watershed climate in the features required for this analysis. These records for Atlanta were analyzed during the Coosa River above Rome, Georgia, survey, along with a simultaneous 10-year rainfall record for Chattanooga, Tennessee. The final "dimensionless diagrams" resulting from the two analyses were so nearly equal that they were combined into a composite diagram, shown in Figure C-5.

In addition to the dimensionless diagram, the analysis gave the result: I_{max} = 1.60 inches per hour for P = 1.50 inches; I_{max} = 2.20 in./hr. for P = 3.50 inches; I_{max} = 3.00 in./hr. for P = 6.00 inches; with intermediate values for other precipitation values.

From the Atlanta dimensionless diagram and the I_{max} relation, the "P_c curves" or "Rainfall Excess Graphs" for each of three design storms were computed. (See Figure C-6.)

Soil Classification - A classification of the soils in the watershed was made with respect to texture. Texture, for the usage here, is defined as the relative proportion of the three size groups (clay, silt, and sand) of individual grains in the soil; these were found originally by mechanical analysis or by field determination. This classification was made solely for use in the infiltration formula and thus occasionally grouped together soils which are not similar in other respects. Since the infiltarion formula method was not used in the Coastal Plain Physical Land Unit, the texture classification was not made for this area. (See Table C-3 for the details including areas within the sample tributaries and the percentages which define the texture.)

A value of the coefficient S of the infiltration formula corresponds to each set of the three percentages which define the texture of a given soil. This value S is found by using a triangular chart.

Cover Conditions, Evaluation Classes - A cover condition classification for hydrologic use is required for the infiltration formula. This formula contains a cover coefficient ("factor of cover") C, which has various values according to the kind of cover. The cover classification need not be a very detailed one for present purposes; hence it groups together some of the individual classes contained in the classification used in planning the land treatment measures.

The values of the "cover coefficient" C as used in the infiltration formula, for the cover conditions occurring in the watershed, are as follows:

VALUES OF COVER COEFFICIENT C

Cover Description	C	
	S - k < .20	S - k > .20
Row Crops* and Miscellaneous	1.00	1.00
Poor Pasture and Poor Abandoned	1.02	1.042
Poor Woods	1.04	1.094
Small Grain and Good Abandoned	1.09	1.185
Medium Past., Close Growing, Poor Kudzu	1.17	1.360
Good Pasture and Medium Woods	1.25	1.541
Good Woods and Good Kudzu	1.36	1.770

*Row Crops are in this first (poorest) class for present conditions. For future conditions, Row Crops are classed with Poor Pasture, etc.,

as the improved practices recommended in the land treatment measures should also increase the infiltration rates for land in row crops.

Each of the seven cover types listed, for each soil classification, gives an evaluation class corresponding to the "soil-cover complex" used in the analysis of infiltration data.

Areas of Evaluation Classes in Each Sample Tributary - These areas were determined in each sample tributary to which the infiltration formula was applied and to the corresponding physical land unit. The areas were taken from the tables used in planning land treatment measures and regrouped according to the hydrologic "evaluation classes."

The stream discharges (which are known for the period of record) are the discharges coming from the actual distribution of cover conditions during this period. In order to make measured flood discharges and present evaluation class areas comparable, areas determined from the sample tributary itself were used. These areas are based on land use practices within the last few years, but field investigations show that no extensive changes in general land use practices have occurred within the period of record.

For future conditions the determination of the areas recommended for the various land use measures was made directly on a physical land use basis. Hence these computed areas were used for future conditions and scaled down by proportion to give the corresponding sample tributary future areas. If a sample tributary represented its physical land unit exactly in all respects, the present and future areas found by this procedure would be exactly comparable. In practice there is some lack of agreement but the sample tributaries are reasonably representative and no serious error results from this cause.

Computation of the Index θ - A value of C and of S was determined for each evaluation class, as previously explained. A series of trial computations by the infiltration formula was next made to determine the "watershed correction factor" k and the corresponding values of θ in each case. Trial computations were continued until the values of θ thus found would give a storm runoff equal to that actually obtained in the precipitation versus runoff investigation previously described.

Computation of Storm Runoff, Present and Future - It was assumed that in the future approximately the same general hydrologic and climatic conditions will hold as at present, the only difference being the areas of each evaluation class. Thus the same k and θ values were used for both present and future conditions and for all design storms. The watershed correction factor k was selected to give the same P versus Y relation as that obtained from the analysis of the storm records. Thus the computed and actual P versus Y curves are the same for present conditions. See Figure C-3 and Figure C-7 for the Broad River curves, present conditions. Future P versus P_o (or Y) curves were computed by the infiltration formula,

using the same θ values as for the present, but evaluation class areas for future conditions. See Figure C-7 for the Broad River sample tributary.

The use of the infiltration formula automatically makes the computed P versus P_o (or Y) relation for present conditions the same as the present average P versus Y relation obtained from the analysis of the rainfall-runoff data. This would also be true if the formula were applied directly to a watershed having an appreciable amount of quick return flow ("subsurface runoff").

Surface runoff is determined from infiltration data when subsurface runoff is not present; but if such subsurface runoff occurs it must be evaluated independently before surface runoff can be known. Hence it was necessary to investigate whether appreciable amounts of quick return flow came from any of the tributary areas of the watershed. Quick return flow is normally caused by the occurrence of large areas of shallow profile soils in the drainage area. A geological investigation showed that such "thin" soils do not exist in important amounts in the watershed. This indicated that quick return flow was not likely to exist in appreciable amounts.

Results from the P versus Y investigation for the sample tributaries confirm the absence of quick return flow. The table below gives average observed Y values for a four-inch rain for various tributary watersheds. Since the P versus Y average curves are approximately similar in shape for streams in this locality, the average Y value for a single heavy rainfall is sufficient to give comparative results.

STORM RUNOFF (Y) VALUES FOR A 4-INCH RAIN

Tributary	Physical Land Unit	Y(inches) for P = 4.00 in.
Savannah River		
Keowee River	Mountain-Foothills	1.33
Broad River	Piedmont Plateau	1.27
Little River (S.C.)	Piedmont Plateau	1.72
Pee Dee River		
Fisher River	Mountain-Foothills	2.15
Third Creek	Piedmont Plateau	1.25
Roanoke River		
Upper Roanoke River	Limestone Valley	1.65
Blackwater River	Mountain-Foothills	1.33
Sandy River	Piedmont Plateau	1.60
Falling River	Piedmont Plateau	1.25

Fisher River, with Y = 2.15 inches when P = 4.00 inches, is known to have considerable quick return flow. The other tributaries listed for the Pee Dee River and the Roanoke River watersheds are known to have no appreciable amounts of such return flow. The range of values of Y for the Savannah River tributaries falls within the range of the average tributary for similar streams considerably below the Fisher River value. This confirms the result indicated by the geological investigation.

Future Storm Runoff from Wooded Areas- Future acreage of medium woods and good woods may be derived from various present covers. It has been decided to claim as benefits from future medium woods and future good woods only those benefits coming from a 15-year growth, on the average, except it is assumed that existing good woods will remain good woods of the best hydrologic type. Thus future good woods derived from existing poor woods or existing medium woods or from open land of any sort will not be claimed as good woods of the best hydrologic type. Data exist which indicate that in general it takes more than 15 years for such woods to reach the best hydrologic condition. Thus it is necessary to separate future medium woods and future good woods acreage into two classes each before using those acreages to obtain future estimated runoff. This separation is made according to the following definitions.

1. Existing Medium Woods. For present conditions this includes all medium woods now existing. (In computing present runoff these acreages, in each soil type, will be given the infiltration coefficient θ corresponding to the highest hydrologic type of medium woods.) For future conditions the acreage of this class will always be taken as zero. That is, the conservative assumption is made that all "medium woods" acreage after the program is in effect will have come from other types of present cover and hence will not reach the best hydrologic "medium woods" status in 15 years.

2. New Medium Woods. Present acreage is always taken as zero. For future conditions this class of "new" medium woods is made up of all the acreage classed as "future medium woods" in the spread sheets of the future program. From the hydrologic standpoint this class of "new medium woods" is not considered as good as long-established medium woods would be and is therefore given a somewhat lower infiltration coefficient θ.

3. Existing Good Woods. For present conditions this includes all "good woods" now in existence. For future conditions the same acreage is used, since the assumption is made that present good woods will remain good woods in the future. This class is the best cover class from the hydrologic standpoint and is given the highest infiltration coefficient consistent with the soil type and watershed.

4. New Good Woods. Present acreage is always taken as zero. For future conditions this class includes all acreage listed in the program spread sheet as "future good woods" minus the spread sheet acreage of "present good woods" ("Existing good woods" as just defined). The assumption here is also conservative: It is assumed that, except for good woods now in existence, all future good woods will not have reached the best hydrologic condition in the period being considered, but instead will be in the condition to be expected after 15 years of growth. Thus this cover will have an infiltration coefficient somewhat lower than the highest permissible one for the soil type. Even "new good woods" coming from present medium woods is assumed not of highest hydrologic type after only 15 years development.

The table below summarizes these definitions and shows that the classes just defined add up to the usual present and future acreages.

Classification of Forest Acreages -- Definitions

Class	Present Acreage	Future Acreage
1. Existing Medium Woods	All present Med. woods acreage	0
2. New Medium Woods	0	All "future" Med. woods acreage
3. Existing Good Woods	All present good woods acreage	All present good woods acreage
4. New Good Woods	0	"Future" good woods acreage minus "present" good woods acreage
Total	All "present" acreage of medium and good woods	All "future" acreage of medium and good woods

The infiltration coefficient θ corresponding to the "new" woods classification is found as explained below. Data exist which show that for average plantings the condition of "good" woods 15 years after establishment corresponds approximately, from the hydrologic standpoint, to an infiltration coefficient which represents 80 percent of the spread between medium woods and good woods conditions (instead of 100 percent spread as for the best type of good woods). Similar results follow from the data for new "medium" woods, 15 years after establishment, with respect to poor woods.

As an example, consider a Cecil f.s.l. soil type which has the infiltration coefficients:

> Poor Woods. . . . . θ = 0.485 in./hr.
> Medium Woods in best condition. . θ = 0.756 in./hr.
> Good Woods in best condition. . . θ = 0.895 in./hr.

Using the "80 percent spread" method, these became

θ for "new" medium woods (i.e., medium woods 15 years after establishment) is

$$0.485 + (80/100)(0.756 - 0.485) = 0.702 \text{ in./hr.} = 0.70 \text{ in./hr.}$$

θ for "new" good woods is

$$0.756 + (80/100)(0.895 - 0.756) = 0.867 \text{ in./hr.} = 0.87 \text{ in./hr.}$$

Channel Improvement

Reconnaissance showed that simple channel improvement work such as snagging, and tree removal from the channel itself, would in general be beneficial in the Mountain-Foothills and Piedmont Plateau Physical Land Units. An investigation was therefore made, for the three sample tributaries representing these Physical Land Units, to determine the effect of such measures from the hydrologic standpoint.

Standard methods were used in this investigation. Approximate gage height versus discharge curves (rating curves), for present conditions and for the future conditions after channel improvement, were determined at one or more typical cross-sections of the stream. The reduction in gage height, for a given discharge, due to channel improvement can then be found from these curves.

Previous field work determined the values of the water-surface slope "s" at the selected cross-sections, the cross-sections themselves, and careful notes about conditions affecting the present value of "n", the so-called coefficient of roughness in Manning's formula. "Slope-area" computations by Manning's formula, using this present value of n, gave the present rating curve. As a check on the estimated value of present "n", a preliminary computation was made in each case for the cross-section at the stream gage. Here an accurate rating curve was available from U. S. Geological Survey records; with this rating curve and the measured water-surface slope and cross-section, the values of "n" can be determined which then substituted in Manning's formula will reproduce the rating curve. The values of "n" computed in this way agreed reasonably well with those given in the field notes. When the cross-section at the stream gage seemed to be representative of the general valley conditions of the stream, this cross-section was given major weight in the investigation because of its known present rating curve. When the gage cross-section was not representative (usually because it had too narrow a flood plain to represent average valley conditions) one or more other cross-sections were investigated and the results used in determining the final rating curves for present and future.

For conditions after channel improvement, the same slope "s" and the same cross-sectional values were used as for present conditions. New values of "n" were used for the future channel section, however. This value of "n" was estimated after a study of future conditions. Actual discharge measurements, with computations for "n" before and after channel improvement, have been made by various agencies on streams comparable to those in the Savannah River Watershed; these results were considered in selecting future values of "n". The value of "n" for the overflow section (flood plain) was kept the same for the future as for the present since no improvement in the flood plain is contemplated by the channel improvement measure.

Present and future rating curves for the Broad River sample tributary are shown in Figure C-8. Present values of "n" for the channel section averaged about 0.054: future values were taken at about 0.046.

For the Little River sample tributary, also representative of the Piedmont Plateau Physical Land Unit, the present and estimated future values of "n" were somewhat higher than for Broad River, averaging about 0.060 for present and 0.050 after channel improvement.

On the Keowee River sample tributary, representing the Mountain-Foothills, approximately the same average values of "n" were used as for Little River: 0.060 for present, and 0.050 for future.

Future peak stages, to result from channel improvement, were found from the two rating curves (before and after channel improvement) using the fact that the peak discharge is practically unchanged by channel improvement (being due mainly to the rainfall and the topography). The peak height, however, is decreased after channel improvement, since the smoother channel can carry the same discharge at a lower gage reading.

The "Peak Stage versus Storm Runoff" relation of Figure C-4 has with it a similar relation for conditions after channel improvement. This curve combines the data shown by the present Peak Stage curve of Figure C-4 and the future (after channel improvement) curve of Figure C-8, but is in a form useful for computation.

Effect of the Recommended Program on Flood Reductions

The present and future P_a versus P relations, previously found for each sample tributary, were used to determine the hydrologic effect of the recommended land use measures. These P_a versus P relations were assumed to apply in general to the Physical Land Unit represented by the sample. Thus, Figure C-7 gives the curves used for both the Broad River sample tributary and for the larger tributaries of the Piedmont Plateau Physical Land Unit. (The smaller tributaries of the Piedmont Plateau are represented by the Little River sample tributary.)

The future Y and Peak Stage values of Table C-2 were found from the present values and the curves of Figure C-7 and Figure C-4.

Stage versus Area Inundated

Area inundated for various stages of storm discharge was determined for the three sample tributaries representing the Mountain-Foothills and Piedmont Plateau Physical Land Units in the following manner:

1. A profile of mean low water elevation, referenced to the gage on the stream, was obtained by field survey. Representative valley and channel cross-sections were obtained at the same time; these were located at approximately uniform intervals insofar as this could be done without excessive field work. This profile and the series of cross-sections extended from the gage location to a point above which the drainage area was approximately three square miles (or to a point above which inundation was not significant). The profile and cross-section were plotted to scale.

2. High water marks of historic floods at various points were determined by field investigation and referenced to the profile. Field work was concentrated on two selected floods of fairly recent date having flood crests different enough to give two maximum flood crest lines reasonably far apart on the flood plain.

3. The high water marks were plotted on the aerial photographs and their elevation indicated. Profile elevations were located on the photographs, and the cross-sections were plotted to scale, with elevations indicated. Any other points whose positions and elevations were known were also plotted on the photographs.

4. With the aid of these points located on the aerial photographs, the line of maximum inundation (boundary of the area of inundation) was drawn on the photographs by stereoscopic methods for each of the two selected floods. This line of maximum inundation, or maximum crest line, of a flood is not a contour line, but in general it is sufficiently near level so that a stereoscope can be used.

5. The area inundated by each of the two selected floods was then planimetered directly from the aerial photographs. Reaches of the stream were used, for convenience, based on the surveyed cross-sections and on intermediate cross-section lines located approximately on the photographs.

6. Areas inundated by floods intermediate between the two selected floods, and by floods greater or less than those two, were found by reaches by an approximate formula. This formula assumes that for a given stage the ratio of the area inundated at that stage, to the planimetered maximum area inundated for a given reach, is proportional to the ratio of the sum of the widths of inundation for the given stage to the sum of the widths of inundation for the maximum flood, the limiting sections of the reach being used for these widths. For assumed gage heights below or nearer the lower of the two selected floods, data from this lower flood were used instead of from the maximum flood. Since this area of inundation formula is approximate, results from it were examined for reasonableness and checks made if necessary, even to the extent of considering "concordant flow" at a cross-section when simpler methods did not decide the question.

The resulting "Gage Height versus Area Inundated Relation" for Broad River sample tributary is shown in Figure O-9; the total area was corrected to give open land only. This relation was used, in the form of a table and changed to area inundated per mile of stream, in computing damage and benefit figures.

Stage versus Duration of Inundation

A study of the duration of inundation computed for each storm on the tributaries of the Coosa River system above Rome, Georgia, showed that there was no significant difference, from the standpoint of damage, in this duration at the depths of inundation experienced. The duration varied from one-quarter of a day to one-half day. Therefore, it was assumed that the duration of inundation for the various depths inundated would be one-quarter day for depths of 1 and 2 feet, and one-half day for depths of 3 and 4 feet or more.

MAIN STREAMS

Gage records exist on the main streams at a sufficient number of locations so that a reasonably accurate determination of the hydrologic features of the past floods could be made, for the period of record of such gages. However, estimates of future main stream floods and flood reductions would be only approximate.

Investigation by members of the survey party on the probable damage reductions to be expected on the main streams from the measures recommended in the report indicated that detailed methods, tying in the damages and benefits to the actual flood heights on the main streams, were not advisable here. Probable total damage reductions on the main streams are not great enough to warrant such details in this survey.

No main stream benefits were claimed for the reaches below the Clark Hill Reservoir on the Savannah River above Augusta, Georgia, nor for the reservoir area, since such benefits appertain to the reservoir project itself. Thus the main stream reaches needing consideration are all above the lower reaches of the river and hence are streams of moderate size. Investigation showed that the main stream reaches in the Piedmont Plateau resembled the streams of the Broad River sample tributary, in size, general topography, and distribution of the flood plains sufficiently so that the Broad River could also be used as an approximate sample for the main stream reaches. Broad River is an unusually large sample tributary (1420 square miles above the gage) and is used as a sample of the larger Piedmont Plateau streams only. Similarly the Keowee River sample tributary (which is large for a sample of the Mountain-Foothills, containing 455 square miles) was used as an approximate sample for the Savannah River main stream reaches in the Mountain-Foothills. In the Mountain-Foothills much of the main stream is hardly larger than the Keowee itself.

It is believed that the reductions obtained by this procedure are as accurate as the available data warrants. Enough data have been accumulated in previous surveys to give an approximate relation between

tributary damage reductions and main stream damage reductions. This allows a check on the reasonableness of reductions obtained in later surveys.

(See Appendix D - Damages, Benefits, and Costs - for details.)

HYDROLOGIC DATA

There is a deficiency of hydrologic information on small watersheds that are most likely to be of value to future reports and to subsequent operations on upstream flood control projects. When authorization is obtained for works of improvement, provision should be made to obtain satisfactory hydrologic information on small watersheds.

Table C-1

SAVANNAH RIVER WATERSHED

HORTON-THIESSEN WEIGHTS FOR THE SAMPLE TRIBUTARIES

(Percent of Tributary Watershed Area in the Precipitation Polygon)

Sample Tributary	Period of Precipitation Record Used (All inclusive)	Precipitation Stations														
		Anderson, S. C.	Calhoun Falls, S.C.	Ware Shoals, S. C.	Athens, Ga.	Carlton Bridge, Ga.	Cornelia Ga.	Gainesville, Ga.	Hartwell, Ga.	Toccoa, Ga.	Washington, Ga.	Caesars Head, S. C.	Clemson College, S.C.	Highlands, N.C.	Rosman, N.C.	Walhalla, S.C.
Little River	1939-1947	10	50	40	--	--	--	--	--	--	--	--	--	--	--	--
Broad River	1926-Nov. 1941 Sept. 1942-1947	--	--	--	10	40	20	0	10	10	10	--	--	--	--	--
	Dec. 1941-Sept. 1942	--	--	--	15	35	0	10	5	25	10	--	--	--	--	--
Keowee River	1935 - 1945	--	--	--	--	--	--	--	--	--	--	15	10	35	0	40
	1946 - 1947	--	--	--	--	--	--	--	--	--	--	0	10	20	30	40

Table C-1

Table C-2 (Sheet 1 of 2)
EVALUATION SERIES OF FLOODS 1/
BROAD RIVER NEAR BELL, GEORGIA
SAVANNAH RIVER WATERSHED

Storm Data		Present		Future			
					After Channel Improvement and after Land Program		
Date	Rain-fall P (in.)	Avg. Runoff Y (in.)	Avg. Peak Stage (ft.)	Peak Stage After Channel Impr. (ft.)	Average Y (in.)	Avg. Peak Stage (ft.)	Percent Reduction In Stage
11/2/27	3.53	1.065	19.35	17.3	0.76	14.2	26.6
12/17/27	2.79	.775	16.6	14.4	.54	11.95	28.0
5/9/28	2.54	.675	15.5	13.4	.465	11.25	27.4
8/15/28	6.00	2.30	29.05	28.0	1.76	23.7	19.4
2/28/29	4.66	1.585	23.85	22.25	1.17	18.35	23.0
3/6/29	6.15*	2.40	29.7	28.8	1.845	24.4	17.8
3/16/29	3.76	1.165	20.2	18.3	.84	15.05	25.5
3/24/29	2.86	.80	16.8	14.7	.55	12.1	28.0
5/2/29	3.71	1.15	20.1	18.15	.825	14.9	25.9
9/28/29	6.50*	2.61	31.0	30.2	2.02	25.8	16.8
10/2/29	7.55*	3.72	34.8	34.4	2.61	30.2	13.2
12/5/31	4.11	1.32	21.6	19.65	.965	16.3	24.5
1/8/32	3.37	.96	18.4	16.25	.67	13.4	27.2
10/20/37	4.38	1.40	22.3	20.4	1.025	16.95	24.0
4/3/38	2.80	.78	16.65	14.45	.54	12.0	27.9
4/8/38	2.74	.755	16.35	14.2	.52	11.75	28.1
7/26/38	5.50*	2.02	27.1	25.8	1.54	21.75	19.75
3/1/39	4.00	1.27	21.2	19.25	.93	15.95	24.9
8/19/39	4.30*	1.405	22.35	20.15	1.03	17.0	23.9
2/19/40	2.57	.69	15.65	13.55	.48	11.4	27.1
8/14/40	5.75*	2.15	28.0	26.9	1.645	22.75	18.75
8/31/40	2.76	.76	16.4	14.25	.525	11.85	27.7
7/7/41	3.53	1.065	19.35	17.3	.76	14.2	26.6
12/5/41	3.05	.875	17.6	15.45	.605	12.8	27.3
12/25/41	3.35	.995	18.65	16.55	.70	13.7	26.5
2/18/42	2.71	.75	16.25	14.1	.51	11.6	28.6
3/22/42	3.52	1.08	19.3	17.25	.755	14.25	26.2
12/30/42	3.38	1.00	18.7	16.6	.705	13.75	26.5
1/19/43	4.12	1.32	21.6	19.65	.967	16.3	24.5
1/28/43	2.74	.755	16.35	14.2	.52	11.75	28.1

* Adjusted for antecedent rain and areal distribution of rain.

Table C-2 (Sheet 2 of 2)
EVALUATION SERIES OF FLOODS 1/
BROAD RIVER NEAR BELL, GEORGIA
SAVANNAH RIVER WATERSHED

Storm Date		Present		Future			
					After Channel Improvement and after Land Program		
Date	Rain-fall P (in.)	Avg. Runoff Y (in.)	Avg. Peak Stage (ft.)	Peak Stage After Channel Impr. (ft.)	Average Y (in.)	Avg. Peak Stage (ft.)	Percent Reduction in Stage
3/22/43	2.43	0.64	15.1	13.1	0.45	11.15	26.15
4/20/43	2.76	.76	16.4	14.25	.525	11.85	27.7
12/27/43	3.13	.905	17.9	15.7	.63	13.0	27.35
3/21/44	4.28	1.40	22.3	20.4	1.025	16.95	24.0
3/30/44	2.74	.755	16.35	14.2	.52	11.75	28.1
4/26/45	4.30	1.355	21.9	20.05	1.00	16.6	21.2
9/14/45	2.90	.82	17.0	14.9	.56	12.3	27.6
12/5/45	2.75	.75	16.3	11.15	.515	11.6	28.8
12/26/45	2.60	.70	15.8	13.65	.49	11.45	27.5
1/8/46	4.35*	1.58	23.8	22.2	1.165	18.3	23.1
2/11/46	2.36	.61	14.85	12.8	.43	10.9	26.6
3/30/46	2.93	.835	17.0	15.0	.57	12.4	27.1
10/10/46	3.76	1.165	20.2	18.3	.84	15.05	25.5
1/21/47	5.06*	1.30	25.2	24.05	1.335	19.85	22.2
3/9/47	2.47*	.65	15.2	13.2	.45	11.2	26.3

* Adjusted for antecedent rain.

1/ The events listed here are limited to storms which will, on the average, produce out-of-bank flow or nearly so. In the study of the rainfall-runoff relations 91 storms were analyzed; the 46 not listed here were caused by a precipitation which, under average conditions, produces a peak stage of less than 15.0 feet on the gage.

Table C-3

SOIL CLASSIFICATION AS TO TEXTURE
(For use in the Infiltration Formula)
SAVANNAH RIVER WATERSHED

Physical Land Unit and Soils	Area in Sample Tributary (Sq. Miles)	Texture		
		% of clay	% of silt	% of sand
Mountain-Foothills				
Fine sandy loams*	13.3	11	28	61
Loams	265.9	15	40	45
Fine sandy loams**	146.9	11	20	69
Clay loams	28.9	25	35	40
Piedmont Plateau				
Fine sandy loams	92.6	10	24	66
Sandy loams	787.1	10	15	75
Clay loams ***	492.1	30	24	46
Silt loams and silty clay loams	3.6	20	58	22
Clay loams ****	44.6	24	31	45
Piedmont Plateau				
Fine sandy loams	15.8	10	24	66
Sandy loams	108.0	10	15	75
Clay loams ***	67.5	30	24	46
Silt loams and silty clay loams	1.6	20	58	22
Clay loams ****	24.1	24	31	45

* Bottomland soils.
** Upland soils.
*** Residual soils underlain by acidic rocks.
**** Residual soils underlain by basic rocks.

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SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA

10 0 10 20 30
SCALE OF MILES

REV 5 26 40
Rev 10 3 19

2-N-6709-1

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2-L-7488-3

-7488-2

FIGURE C-1

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SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA

2-N-6709-1

Fig. C-2

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R SAVANNAH RIVER SURVEY

nin the Savannah River Drainage Area)

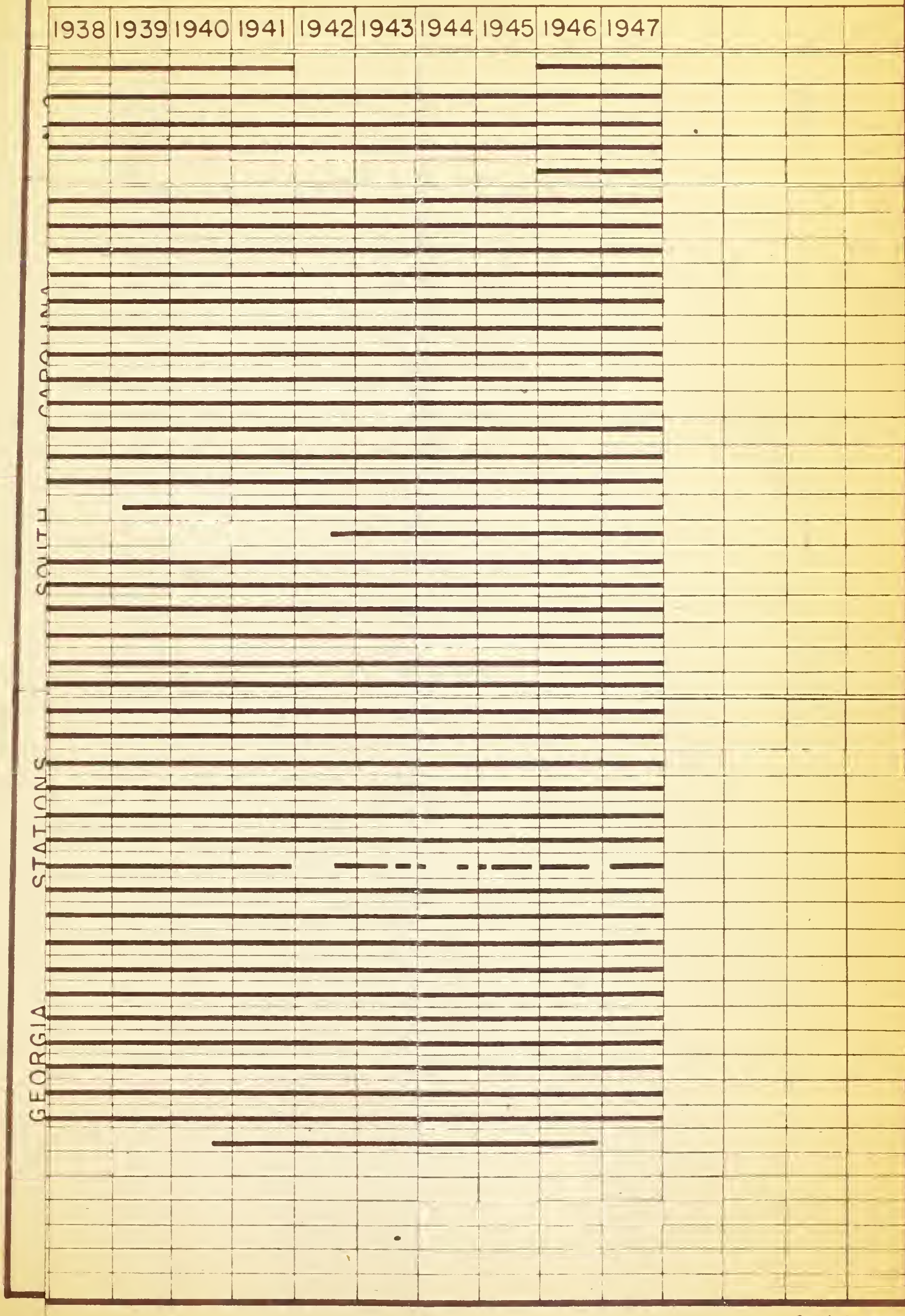

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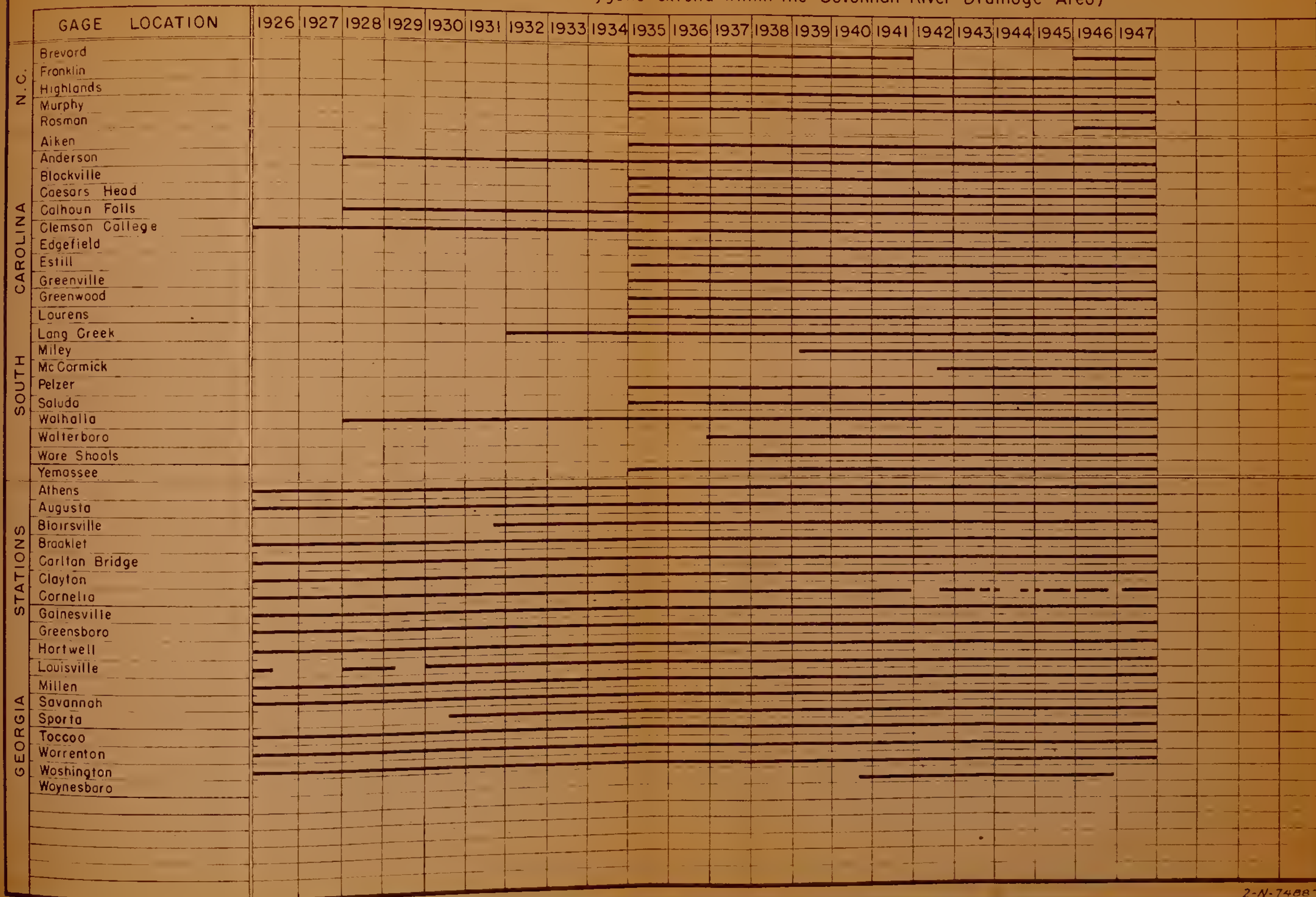
FIGURE C-2

RAIN GAGE STATIONS 1926-1947 FOR SAVANNAH RIVER SURVEY

(Stations whose Horton-Thiessen Polygons extend within the Savannah River Drainage Area)



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3-49

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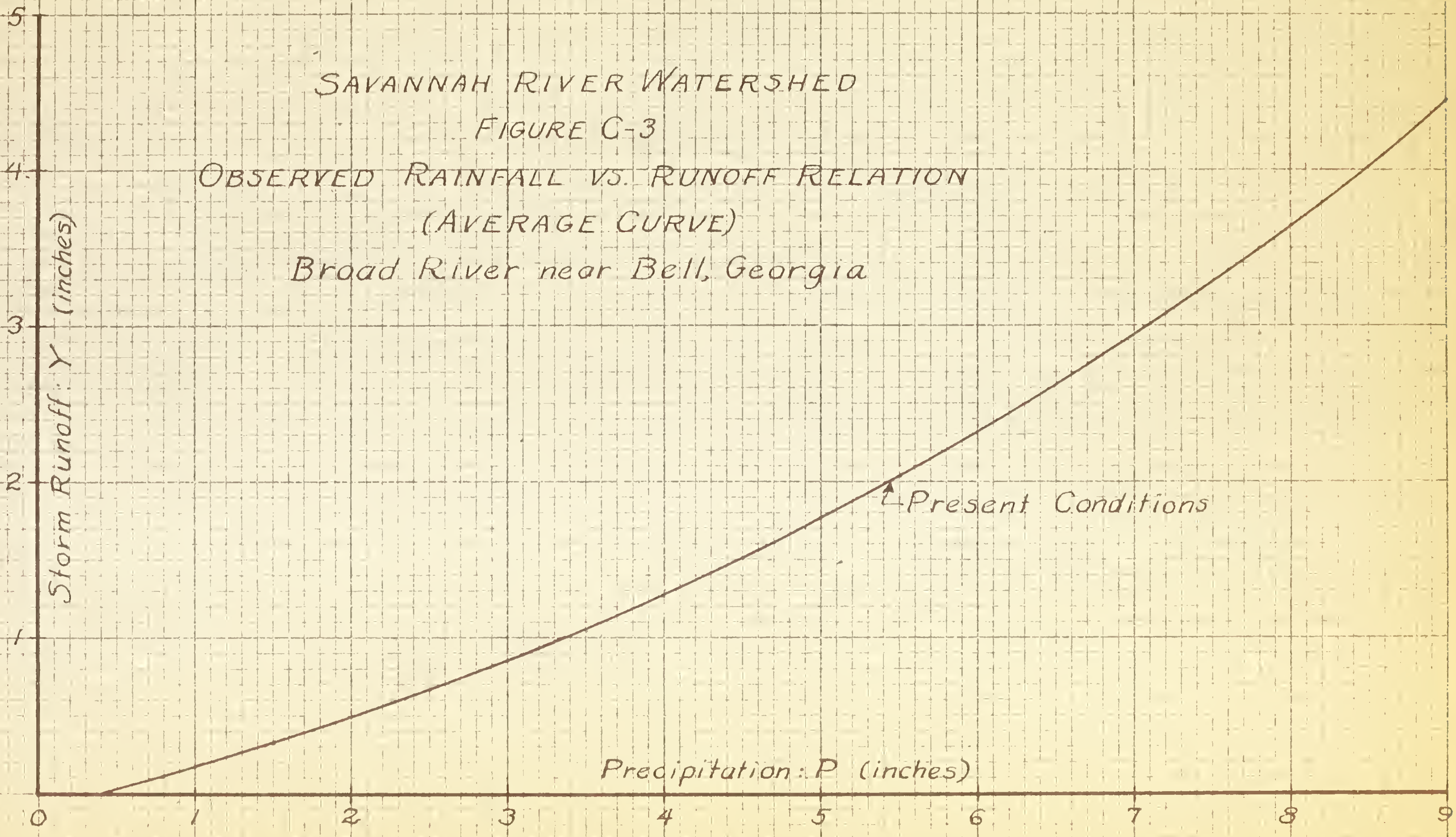

Fig C-3

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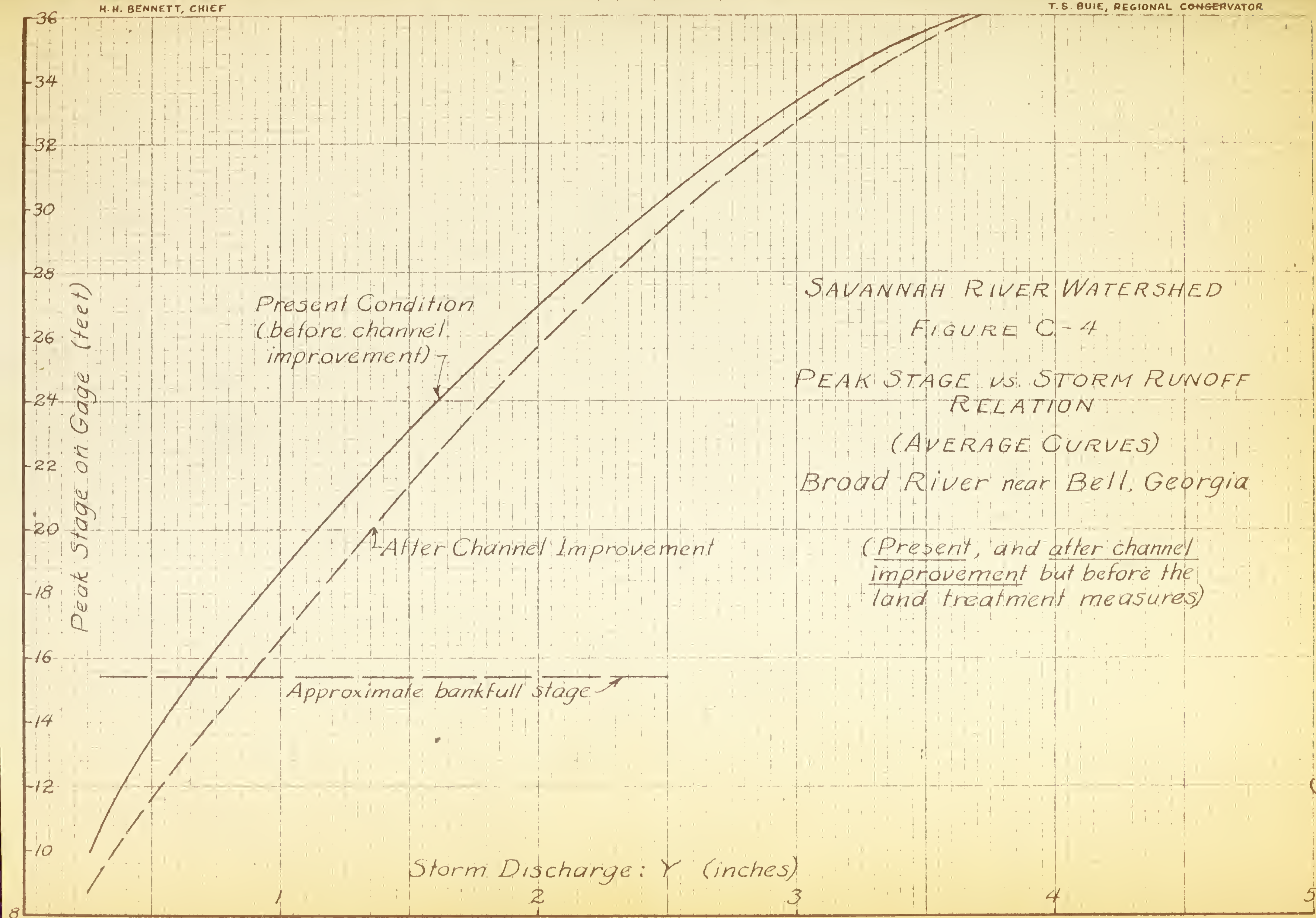


Fig. C-4

2-L-7488-4

Soil Conservation Service
H. H. Bennett, Chief

U. S. Dept. of Agriculture

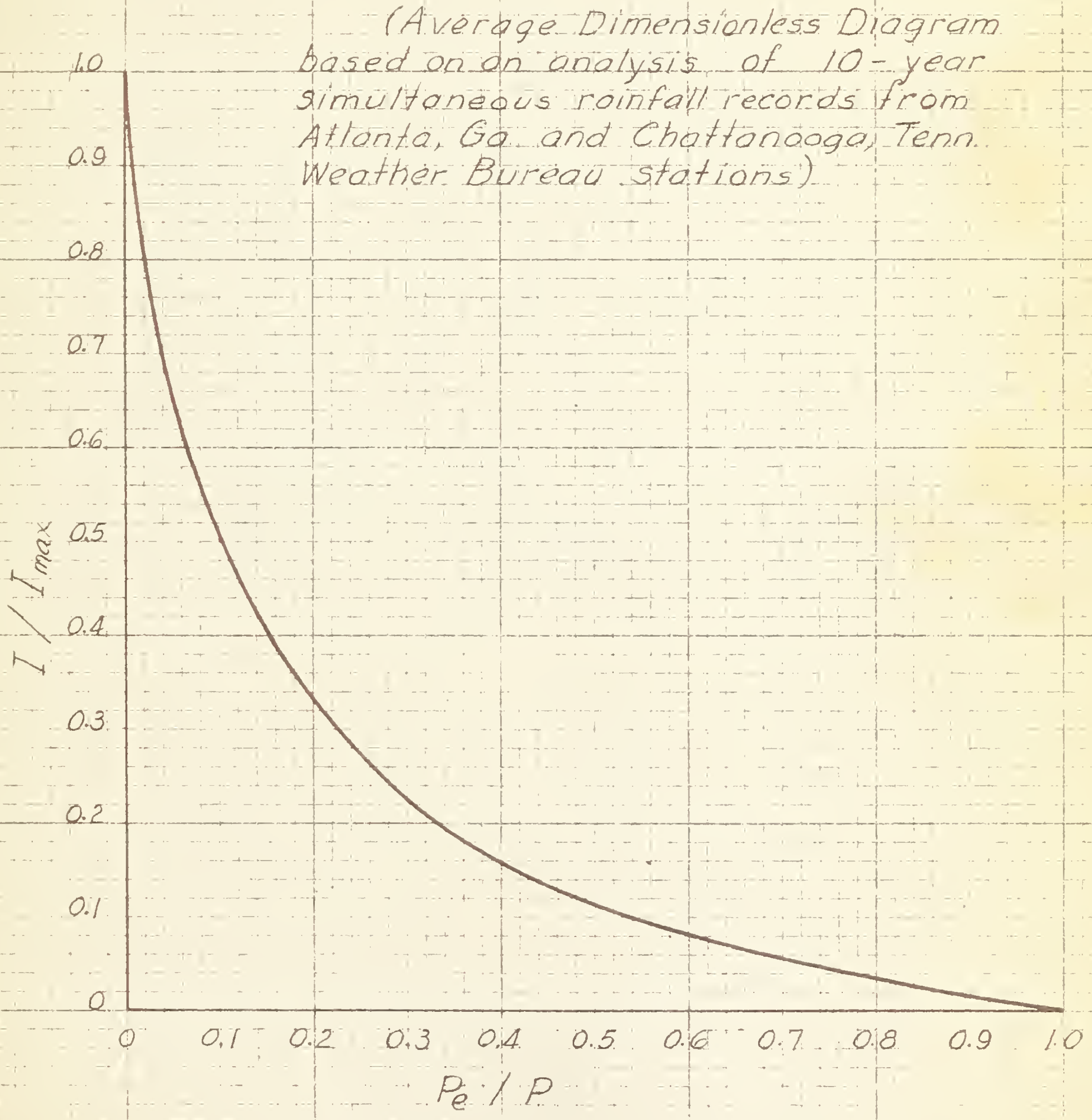
Southeastern Region
T. S. Buie, Regional Conservator

Savannah River Watershed

Figure C-5

Dimensionless Diagram

I / I_{max} versus P_e / P Relation



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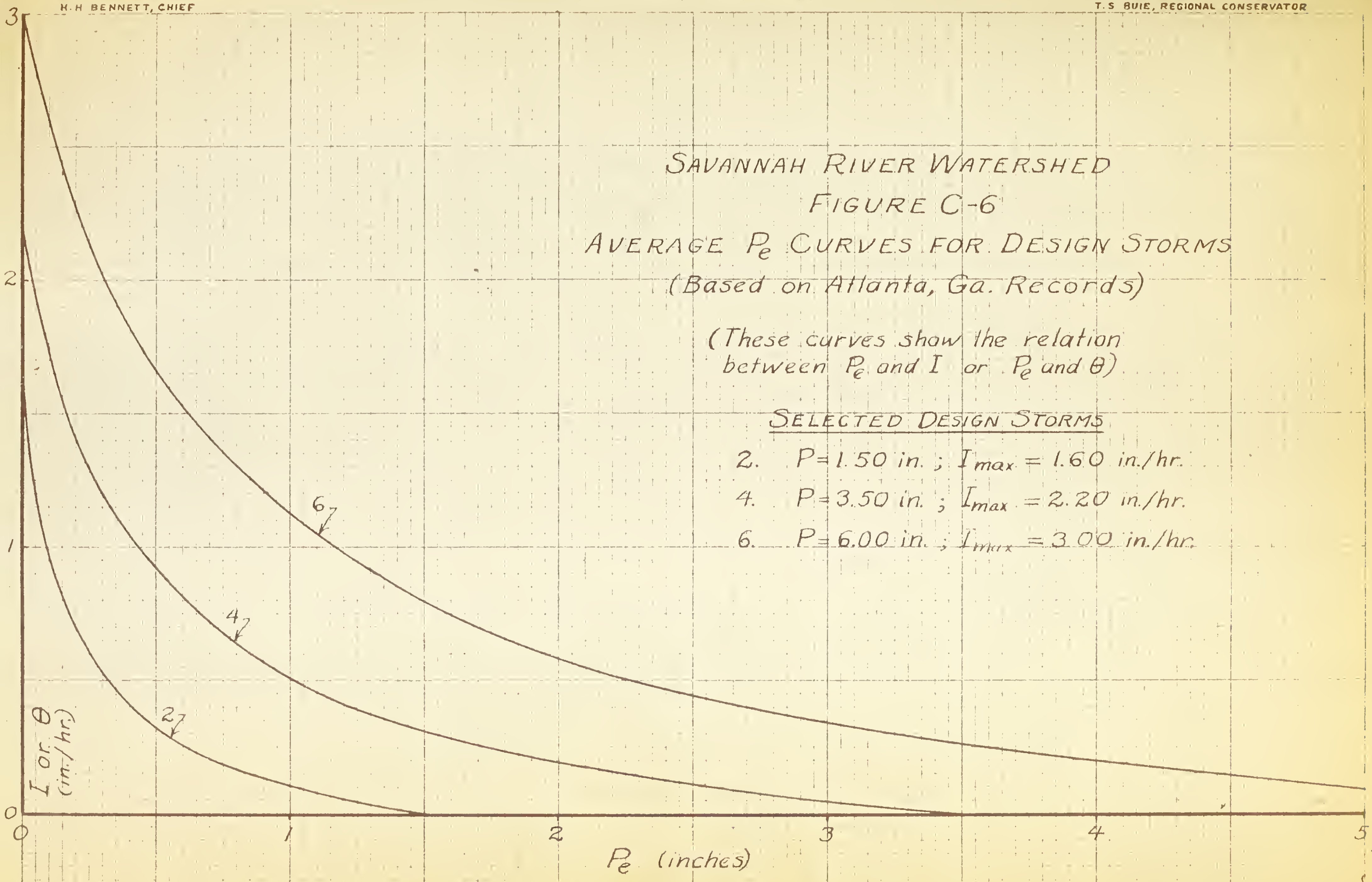

Fig. C-6

2-L-7488-6

U.S. Department of Agriculture

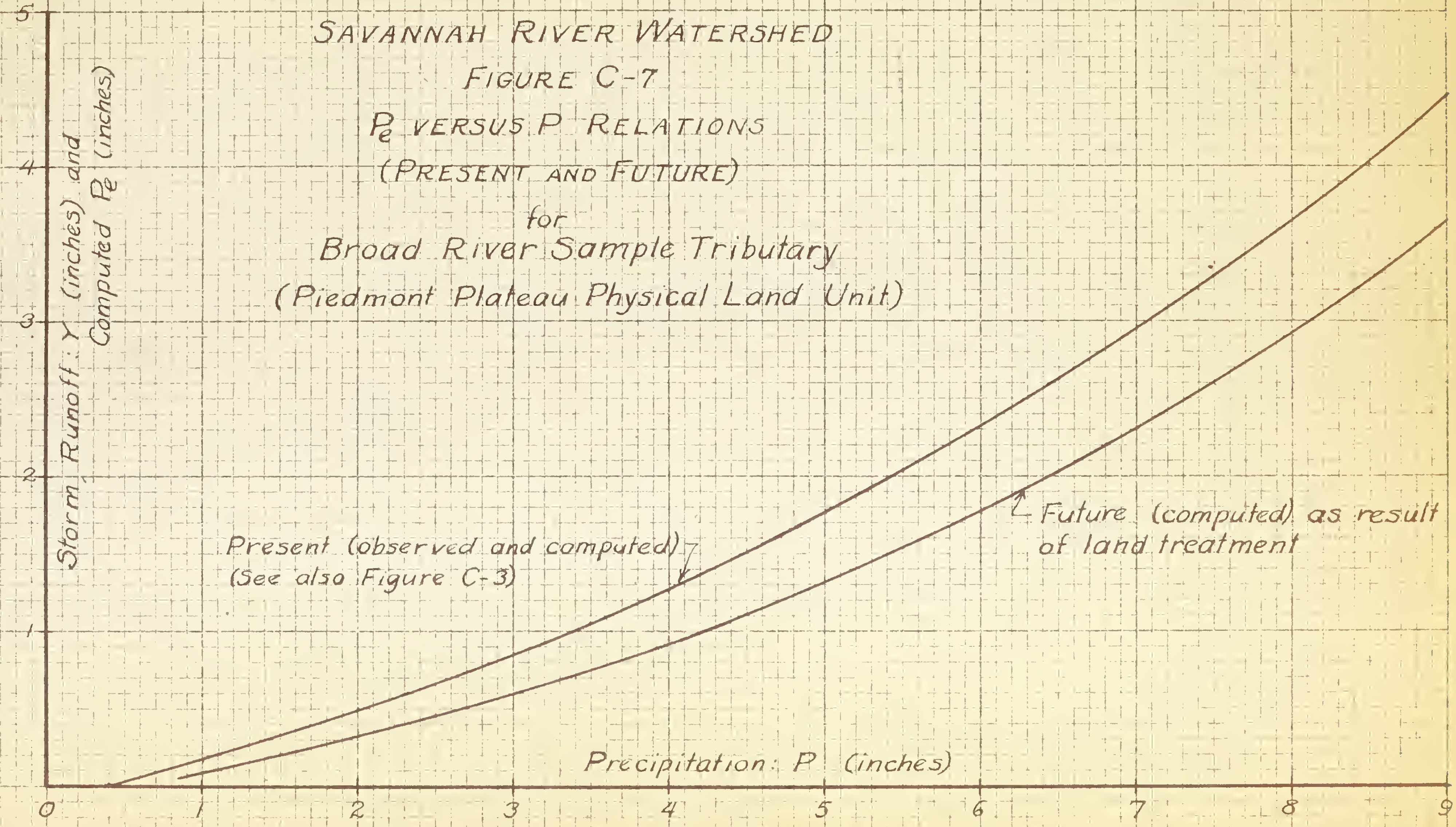

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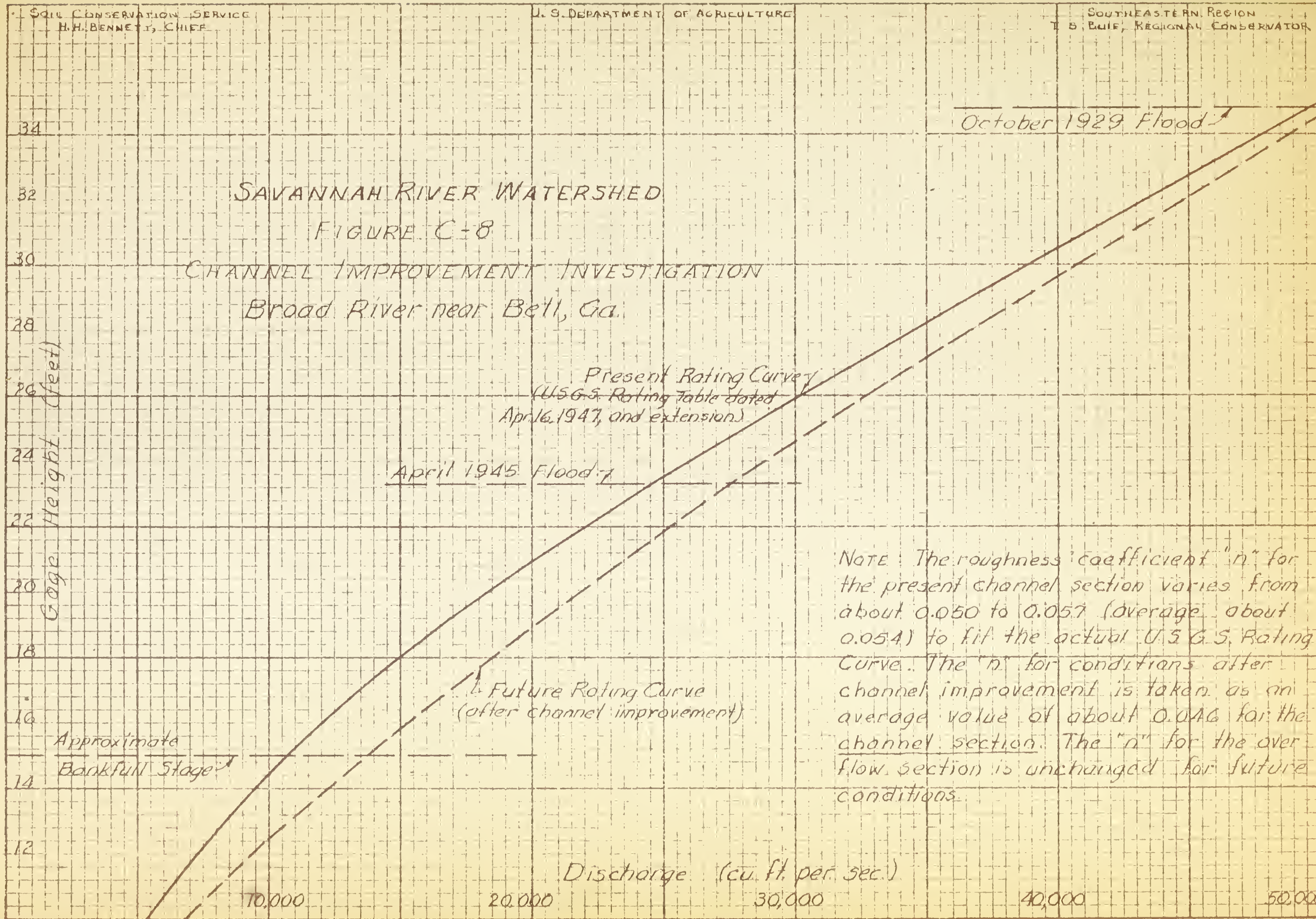
Fig. C-7

Fig. C-8



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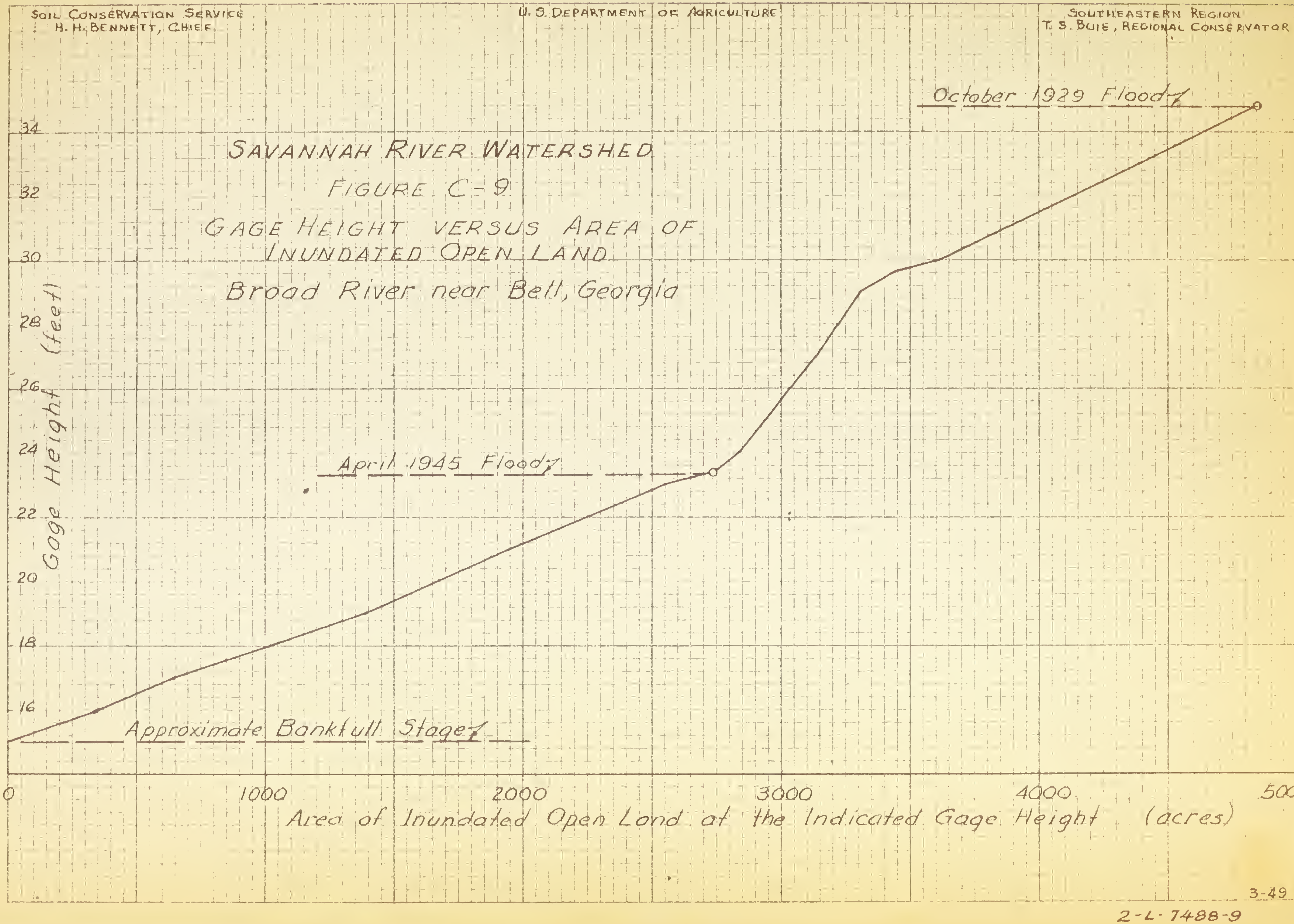
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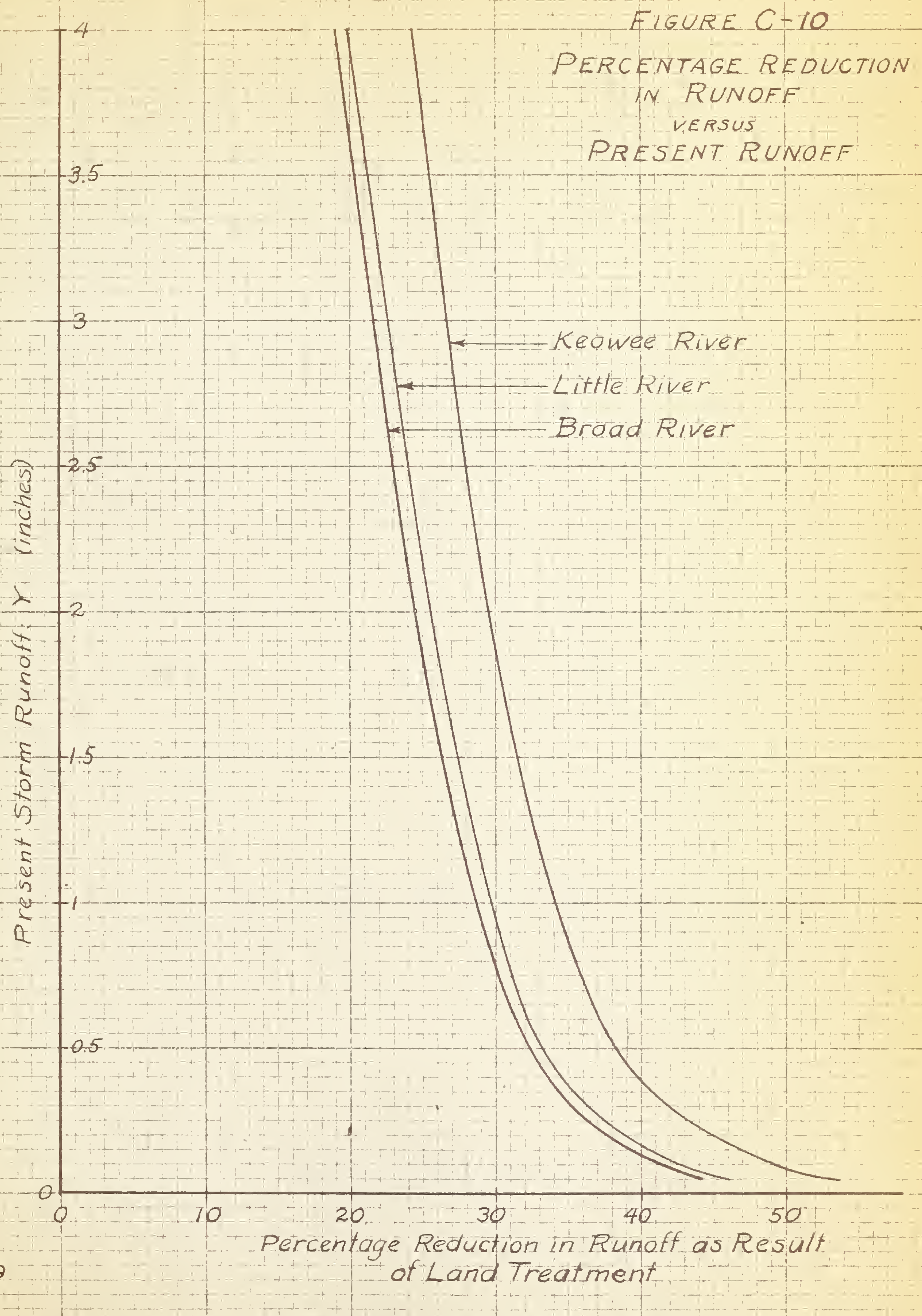
SAVANNAH RIVER WATERSHED
FIGURE C-9
GAGE HEIGHT VERSUS AREA OF INUNDATED OPEN LAND
Broad River near Bell, Georgia
October 1929 Flood
April 1945 Flood
Approximate Bankfull Stage
Gage Height (feet)
16
18
20
22
24
26
28
30
32
34
0
1000
2000
3000
4000
5000
Area of Inundated Open Land at the Indicated Gage Height (acres)
3-49
2-L-7488-9

Fig. C-9

2-L-7488-10



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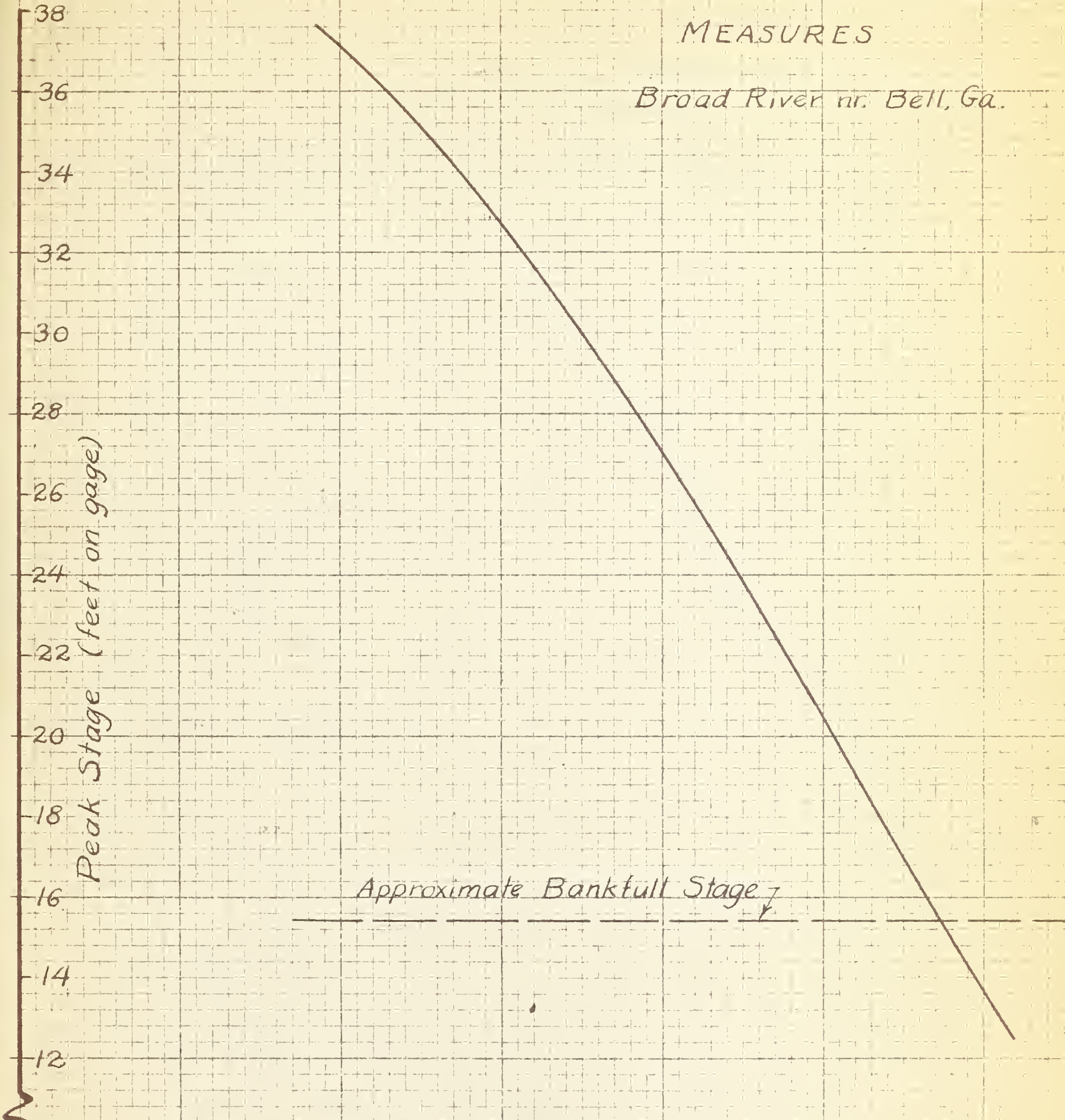
2-L-7488-11

FIGURE C-11

PERCENTAGE REDUCTION IN PEAK STAGE DUE TO COMBINED REMEDIAL MEASURES

Broad River nr. Bell, Ga.



1949

APPENDIX D

DAMAGES, BENEFITS AND COSTS

SAVANNAH RIVER WATERSHED

TABLE OF CONTENTS

Page

Tables

PART I - FLOOD WATER AND SEDIMENT DAMAGES AND BENEFITS

FLOOD WATER DAMAGES

Introduction

Damage investigations were conducted on sample tributary streams. The Keowee River in South Carolina was used as a sample representing the Mountain-Foothills. Little River in South Carolina and Broad River in Georgia were used as samples for the Piedmont Plateau. Brier Creek in Georgia was used as a sample for the Coastal Plain.

No damage estimates were made on the main stem below the Clark Hill Dam. Little or no benefits could be claimed for reduction of damages below this point on the main stream by a watershed treatment program. The upper part of the main stem above the Clark Hill Reservoir is comparable to the sample tributaries. It was treated as a tributary in the general estimate of damages and damage reductions.

Flood water damages on the Savannah tributaries are largely agricultural. Consequently, investigations were largely in regard to crop, pasture, and land damages. Estimates were obtained from state highway departments and railroads about the damages to highways and railroads. All estimates are based on 1947 prices.

General Procedure and Methods

Farmers owning and operating crop and pasture land within the flood plain of sample tributaries were interviewed to obtain detailed information. This data included land use distribution within the flood plain, average yields of crops and pasture when not damaged by floods, and percent damage by depths of inundation by seasons for individual crops and pasture when flooded. Further observations and contacts were made in each sample tributary and other tributaries to supplement and check the information gained from individual farmers. Much useful information was obtained from the State Colleges of Agriculture and State agricultural statisticians on the cost of production of various crops, prices received by farmers, and practices applicable to the areas being studied. The experience of local agricultural field workers served as a guide in obtaining adequate local information.

Flood plains were outlined on aerial photographs for two floods of record on each sample tributary. These areas were planimetered to determine the inundated area within the flood plain as related to flood stage. The area of open land and woodland within the flood plain was also determined by planimetering.

Damageable Values Per Acre

The damageable value per acre for each crop grown in the flood plain was estimated for each month of the year by Physical Land Units. Then a weighted average damageable value by months for all crops grown on a composite acre of open flood plain land was computed. Examples of these two steps in estimating damages are in Tables D-1 and D-2.

In Table D-1 the values are mid-month averages per acre for each crop grown in the flood plain. In Table D-2 the values from Table D-1 have been weighted by the proportionate area of open flood plain land each crop occupies to develop a total damageable value for a composite acre of open flood plain land in the Physical Land Unit.

Seasonal Damage by Depths of Inundation

Estimates from selected farmers having considerable experience in growing crops in the flood plain were used to estimate the percent of damage resulting from floods of varying depths to various crops for each month of the year. These estimates were adjusted to a reasonable figure for use in making estimates of damages per acre by depths of inundation for the various crops. They were then checked against estimates (made by farmers in the same general area) of monetary damages from specific floods and with data obtained on other watershed studies where similar conditions prevail. The percentage estimates were used in computing a weighted average damage per acre for all crops by depths of inundation. See Tables D-3 and D-4 for examples of the procedure used in this computation. Percentages in Table D-3 multiplied by corn values by months in Table D-2 give damages to corn by depth of inundation by months as shown in Table D-4.

Damages by depth of inundation and by months were computed for each crop (including pasture) grown in the flood plain. These damages were summarized to give flood damages to crops and pasture per acre of open flood plain land by months and by depth of inundation as shown in Table D-5. The same general procedure was used in computing damages to fixed improvements except that it was not necessary to vary damages to fixed improvements by months. It was recognized that there are some differences in the nature of damages to fixed improvements between the summer and winter seasons. But, all factors considered, the differences in dollar damages would be negligible.

Stage-Area by Depth of Inundation Relationship

The area of land inundated by any flood stage by one foot intervals of inundation was determined from valley cross-sections based on flood lines for two floods of record varying in stage, and then measuring these areas on aerial photographs of the sample tributary stream. The amount of open land flooded by intervals of one foot depth of inundation was determined from the aerial photographs by proportion. Field studies indicated that no corrections were necessary in the area of open flood plain land within the various flood stages.

A summary of the acres of open flood plain land inundated by one foot depth of inundation intervals for each foot difference in the average peak flood stage is shown in Table D-6. For expansion purposes, this acreage table was calculated on a stream mile basis by dividing the total acres of open flood plain land inundated by the stream mile length of the sample tributary stream.

Stage-Damage Relationship

Tables indicating stage-damage relationships per stream mile were prepared for each sample tributary. To obtain the crop and pasture damage per stream mile on a sample tributary for a given month and stage height, the areas inundated per stream mile at various depths of inundation for a given stage height (Table D-6) were multiplied by the amount of damage per acre for the respective depths of inundation (Table D-5). The sum of these damages is the crop and pasture damage per stream mile for a flood of given stage height. Stage-damage relationships for the Broad River sample tributary are shown in Table D-7.

Average Annual Agricultural Damages Per Stream Mile

Average annual flood damages per stream mile were computed for each sample tributary by adding the damages per mile resulting from each flood during the period of record and dividing by the number of years in the period.

Floods during the period of record are listed chronologically giving the date and the average peak stage of each flood (Table C-2, APPENDIX C, HYDROLOGY). For each flood of record, the agricultural damage was obtained from the table showing stage-damage relationships (Table D-7) and adjusting for sequent flooding.

When more than one flood occurs within a given season of the year, all floods occurring in that season after the first flood are called sequent floods. Each sequent flood will do less damage to the acreage previously inundated than did any preceding flood of the season. This is taken into consideration to avoid over-estimation of damages.

The estimated average annual agricultural damages per stream mile without a program (present damages) for the various sample tributaries in each Physical Land Unit are as follows: Mountain-Foothills area (Keowee River, South Carolina, hydrologic sample), $340; Piedmont Plateau area (Broad River, Georgia, and Little River, South Carolina, hydrologic samples), $185; and Coastal Plain area (Brier Creek, Georgia), minor (Table D-8).

Agricultural Damages With Channel Improvement Only and With a Complete Program

In estimating future damages with channel improvement alone and also with a complete program, the land use and damageable values on the flood plain were assumed to remain the same as that used in estimating present damages. The estimates of reduction in agricultural losses result from reductions in average peak stages and area inundated.

The estimated average annual damages per stream mile in the future with channel improvement only by sample tributaries in each Physical Land Unit are as follows: Mountain-Foothills area, $280; Piedmont Plateau area, $150 for Broad River and $137 for Little River. A complete program, including channel improvement, is expected to reduce these damages to: Mountain-Foothills area, $153; Piedmont Plateau area, $84 for Broad River and $80 for Little River.

Present damages were obtained by multiplying the amount of the average annual damage per stream mile by the number of miles of streams subject to flooding. Future damages with channel improvement alone and also with a complete program were obtained in a similar manner. Estimated total agricultural damages without a program, with channel improvement alone, and with a complete program are shown in Table D-8 by Physical Land Units.

Damages to Roads and Railroads

Estimates were obtained from the state highway departments in South Carolina and Georgia on the annual flood damages sustained on roads and bridges. Similar estimates were obtained for railroad property from officials of the Southern Railway Company. A summary of the estimated annual damages and benefits to roads and railroads within the watershed is shown in Table D-9.

Other Damages

Damages to fixed improvements such as farm fences, farm roads, farm drainage, and farm buildings were not great enough to separate as an individual item. These damages, where they occurred, were incorporated in the agricultural damage estimates. Occasional damage to livestock, poultry, and equipment occurs but is of small consequence. No estimate was made of such damages.

Indirect and Intangible Damages

Loss of life resulting from floods has been low. Illness associated with floods has not been a serious problem. Floods have contributed to the seriousness of the malaria problem. At the present time the incidence of malaria is very low.

There are additional indirect damages that are not of a physical nature but are the result of floods. Such damages are the loss of business, loss of wages, disruption of public utility services and transportation, loss of rent, and costs of relief and sanitation. No attempt was made to evaluate these damages.

SEDIMENT AND RELATED DAMAGE

Sediment Damage to Flood Plain

Mountain-Foothills

In the steeply rolling to mountainous Mountain-Foothills section, bottom lands make up about 3.4 percent of the area. The flood plains, while not extensive, are generally well drained and highly productive. Bottom lands represent a considerable part of the cultivable land in this section.

Sediment damage to flood plains is not serious in this part of the watershed. Deposits of sand occur frequently but in most cases are medium to fine textured and not particularly damaging. The bottom soils are predominantly well drained, fine sandy loam to silt loams.

There is some scour damage and stream bank erosion during major floods. Practically all farmers in the area allow the stream banks to grow up in trees and brush as a protection from stream bank erosion and to reduce the velocity of overbank flows.

Most of the stream channels have rock ledge or gravel bottoms. Except for a brushing and snagging problem, they are free of major obstructions and channel fill is of minor importance. Low sand and gravel bars occur occasionally but are migratory and do not cause serious channel obstruction. Damage from swamping is of minor importance.

Deposition of coarse grained sediments has damaged 5.3 percent of the flood plain.

The Keowee River sample tributary was used to represent this area.

Piedmont Plateau

The Piedmont Plateau is the most extensively cultivated section of the watershed. It is a rolling area practically all of which has been cleared and cultivated at one time or another. Sheet and gully erosion are very active on the cleared areas. Gully erosion is particularly serious. About 9.4 percent of the Piedmont area is subject to flooding.

Flood plains along the main stem and its principal tributaries, the Broad, Tugaloo, and Seneca Rivers, are relatively narrow and flanked by steep sided hills. Except for occasional sand bars, these streams appear to be maintaining adequate channels. Banks are usually high, relatively stable, and heavily vegetated with sycamore, birch, poplar, and willows. Bank caving occurs occasionally. Trees which have fallen into the channel from caved banks cause a snagging problem. Bottom soils along the main reaches are predominantly well to imperfectly drained silt to sandy loams. High natural levees of sand usually occur on both sides of the channel. Stream gradients throughout the entire Piedmont are frequently controlled by rock shoals.

Poor channel conditions are of general occurrence on the tributary streams. Bottom lands are considerably more extensive than along the main rivers. Large amounts of sand and other erosional debris contributed from the seriously eroding uplands have caused widespread channel fill. Channel plugs, islands, sand and mud bars are common. Old tree trunks in many of the tributary channels have caused a serious snagging problem. Many channels are completely filled with sediment.

Channel fill, with the accompanying rise of the water table, has resulted in swamping of a large portion of the Piedmont bottom lands. Swamping, coupled with increased frequency and severity of flooding, has kept a large part of the flood plain out of agricultural use. Farmers in the area stated that practically all of the flood plain was under cultivation in years past, some as recently as 35 to 40 years ago.

The swamped condition of the flood plain varies from a permanently wet condition with the water table at or above the general flood plain level all year around to an imperfectly drained condition with the permanent water table as much as a foot or more below the surface. All of the area mapped as swamped was in brushy woodland. Poor drainage combined with frequent overflow has made the utilization of this land too hazardous for agricultural use.

Deposits of coarse, infertile sediment, often 3 feet or more in depth, affect some of the flood plain. Frequent scour channels indicate overflows of considerable velocity. Stream bank erosion is of minor importance. Deposition and scour often occurs as an overlapping damage with swamping, particularly on the tributary streams. When this is the case, swamping is the only damage considered and is evaluated as an 80 percent loss of production value.

In the Piedmont area swamping has damaged about one-half of the total flood plain.

The sample tributaries used were Broad River, Georgia, and Little River, South Carolina.

Coastal Plain

The Coastal Plain Physical Land Unit is a relatively featureless area except for a rough but low sand hill section near the fall line. Flood plains are wide and continuous. Most of the bottom soils are inherently wet and unfit for cultivation without proper drainage. Practically all of the bottom land area is in woodland, predominantly water loving hardwoods.

No damage was found on Brier Creek, the sample tributary. Sediment and related damages are of minor importance in this physical land unit.

Method of Making Flood Plain Sediment Damage Surveys

In initiating the survey a reconnaissance was made of the entire watershed to determine the general extent and seriousness of the sedimentation problem. Then the sample areas were selected for detailed study. Detailed sediment damage surveys were made on sample tributaries within each physical land unit. Aerial photographs with a scale of 1 inch = 1320 feet were used as a base. The purpose of this mapping was to show the extent of physical changes in the flood plain resulting from accelerated sedimentation. A three place symbol was used to show, in a roughly quantitative manner, the several types of sediment damage.

The first of these variables indicated the extent of modern deposits of infertile sediment on the flood plain. The second symbol represented swamping, the result of channel fill and subsequent raising

of the water table under adjacent bottom lands. The third damage was scour, the cutting of channels or removal of bottom soils by flood waters.

The following legend was used when making the sediment damage studies:

Deposition of Infertile Sediment:

0 = No sediment deposits.

1 = 0 - 33% of area covered by sand to depths of 8" or more.

2 = 33 - 67% of area covered by sand to depths of 8" or more.

3 = 67 - 100% of area covered by sand to depths of 8" or more.

Swamping:

1 = Bottom land formerly suitable for cultivation now suitable only for woodland.

Scour:

0 = No scour.

1 = 0 - 33% of area scoured to depths of 12" or more.

2 = 33 - 67% of area scoured to depths of 12" or more.

3 = 67 - 100% of area scoured to depths of 12" or more.

Method of Calculating Damages and Benefits

The method used to calculate damages was based on determining a uniform annual increment of loss. Damage was considered as a loss of production value. The basic data used to determine amounts of sediment and related damages to flood plains were obtained from the sedimentation surveys. The following procedure was used when calculating damages.

1. The survey maps were planimetered to determine the extent, in acres, of each type and intensity class of sediment damage.

2. Values were assigned to each damage class in order to convert physical damages to monetary terms. The loss of production value resulting from the different types and degrees of damage was based on an average annual net return to the farm per acre of undamaged bottom lands within each physical land unit. See table below.

AVERAGE ANNUAL NET PRODUCTION LOSS RESULTING FROM SEDIMENT DAMAGE
SAVANNAH RIVER WATERSHED

Type of Damage	Damage Class	Percent	Annual Per Acre Loss of Production Mountain-Foothills Dollars	Piedmont Plateau Dollars
Deposition	1	20	4.40	2.20
	2	40	8.80	4.40
	3	60	13.20	6.60
Scour	1	5	1.10	.55
	2	10	2.20	1.10
	3	15	3.30	1.65
Swamping	1	89		9.80

3. The rate of loss (1948) was arrived at for each type of damage within the sample by multiplying net production loss for each damage class by the number of acres within that class, Table D-10.

4. The only criterion of sediment damage was the condition of the flood plain at the time of the survey. The damage mapped represented the total accumulated net production loss at the time of the survey (1948). In order to calculate annual increment of loss of production value, it was first necessary to determine the number of years during which the loss had occurred. The mid-point between the beginning and peak years of agricultural development was used as the beginning of accelerated sediment damage. The number of years between this date and 1948, the year the sedimentation survey was made, represented the period of accelerated sedimentation damage. See table below.

PERIOD OF CUMULATIVE FLOOD PLAIN LOSS
SAVANNAH RIVER WATERSHED

	Mountain-Foothills	Piedmont Plateau
Beginning of Agricultural Development (Year)	1794	1768
Peak of Agricultural Development (Year)	1900	1902
Median Point (Beginning of Sediment Damage-Year)	1847	1835
Sediment Damage Mapped (Year)	1948	1948
Years of Cumulative Loss (Years)	101	113

5. The annual increment of net production loss within the sample was determined by dividing the annual net production loss for the year of the survey (1948) by the number of years during which accelerated sedimentation damage had been taking place, Table D-11.

6. The annual increment of loss of net production value was divided by the total number of acres of flood plain within each sample to determine the annual loss per acre, Table D-11.

7. Damage was expanded from the sample to the entire physical land unit by multiplying the annual increment of loss per acre occurring within the sample by the total number of acres of flood plain for which the sample was considered representative, Table D-12. The area of flood plain inundated by construction of the Clark Hill Reservoir was not included in the totals for the Piedmont Plateau.

8. In order to determine benefits resulting from the recommended program, it was necessary to estimate the percent reductions of flood plain loss resulting with the remedial measures in effect. (See Effect of the Remedial Program on Reduction of Sedimentation Damage, pages 13 to 14.) The annual increment of loss with the program in effect was determined by using the percentage figures shown in the table on page 14. The difference between the average annual equivalent of loss, without and with the program, was the average annual benefit, Table D-13. When calculating the average annual equivalent of loss from deposition in the Mountain-Foothills area, it was assumed that without the program, damage would increase at the present rate for the next 100 years and then become constant. With the program in effect, the average annual equivalent of loss from deposition was assumed to increase at a lesser rate for the next 100 years and then become constant. The multiple 24.505 (present value of an annuity of 1 per year at 4 percent for 100 years) was used to obtain the average annual equivalent of damage with and without a program. This method gives the same result as would a computation which considers damages as an annuity that remains constant after increasing for a period of years.

In the Piedmont area where sand deposits, scour or swamping damages have already affected more than half of the flood plain, the point of maximum damage, without a program, will be reached sooner than in the Mountain-Foothills. The point of maximum damage, without a program, was assumed to be 50 years hence. With a program of channel improvement only or with a complete program, the point of maximum damage was assumed to be 100 years hence. In the sample calculation given below, the loss figure used is $438 which is the average annual increment of loss from deposition in the Piedmont Physical Land Unit.

Sample Calculation

1. Average annual increment of loss without a program = $ 438

2. Average annual equivalent of loss without a program = $438 X 21.48218 (present value of an annuity of one year for 50 years at 4 percent) = $ 9,409

3. Average annual increment of loss with a program = $438 X .35 (program estimated to be 65 percent effective in reducing sediment damage) = $ 153

4. Average annual equivalent of loss with a complete program = 153 X 24.505 (present value of an annuity of one per year for 100 years at 4 percent) = $ 3,749

5. Average annual benefit = $9,409 - 3,749 = $ 5,660

Sedimentation of Reservoirs

There are more than 50 reservoirs in the watershed. Most of them are small mill ponds, water supply, or recreational reservoirs. A number of the larger structures are channel type built primarily for head. Storage is not important in the case of these run-of-the-river developments. Ordinary stream flow is usually sufficient to meet water demands. Sediment accumulation in such basins has little effect upon operation of the plant; consequently, cannot be claimed as a damage. The more important reservoirs are listed in Table D-14.

The Portman Shoals, Gregg Shoals, Stevens Creek, and August City dams are channel type structures built primarily for head. New Savannah Bluff Lock and Dam was constructed for the purpose of creating a reservoir and improving navigation. Investigation of a series of small power developments on Horse Creek in Aiken County, South Carolina, showed low rates of sediment accumulation and a small initial investment. Immediately above Russell Lake, the largest recreational lake in the watershed, is a small reservoir (Nancytown Lake) which traps most of the sediment before it reaches Lake Russell. Lake Issaqueena, in Pickens County, South Carolina, is a recreational reservoir built by the Civilian Conservation Corps. Lake Secession is a power development owned by the city of Abbeville, South Carolina.

A series of six power dams, owned by the Georgia Power Company, is located on the Tallulah and Tugaloo Rivers near the headwaters of the Savannah River. Together these reservoirs have an estimated total (1948) replacement value of more than $56,000,000. They are located one below the other. Each acts as a sediment trap for the ones below. These structures will be benefited by the recommended program even though rates of sedimentation are low. This is due to the high per acre foot replacement cost of storage.

The most important single development in the watershed is the Clark Hill Reservoir. This is a multiple-purpose project now under construction by the Department of the Army, Corps of Engineers, on the Savannah River 21.7 miles above Augusta, Georgia.

Lake Issaqueena is the only reservoir in the watershed on which a detailed sedimentation survey has been made. A survey of the sediment deposits and of the watershed area above the lake was first made in 1941. A resurvey of the lake sediments and of the cover conditions was completed in 1949. A recent publication 1/ makes a detailed analysis of the two surveys. Briefly, the area above Lake Issaqueena has been producing sediment at a very high rate because of improper land use. However, soil conserving measures newly established on farms within the watershed have greatly reduced the volume of sediment reaching the lake. At the time of the first survey it was found that for every acre in the watershed 3.76 tons of soil were being washed into the lake each year. The 1949 survey showed that only 1.80 tons per acre per year had been deposited into the lake since the 1941 survey. This change to less sediment is reflected in land use changes largely responsible for the decrease. The principal ones are: (1) more than 500 acres of newly planted pines on critical slopes, (2) the retirement of many of the steeper fields from clean cultivated crops to close growing vegetation, and (3) the switch from solid field planting to strip crop rotation with standard terraces and protected waterways.

The Tallulah River Watershed is mountainous and highly wooded. Rates of sediment production are low. The Tugaloo River Watershed is similar to that of the Tallulah River, but has considerably more cleared land and a somewhat higher rate of sediment production.

Reservoirs Benefited

Nine reservoirs, Table D-15, will be benefited by the recommended program. The structures not benefited by the program either represent too small an investment, are already filled, or have very low rates of sedimentation.

Method of Calculation

A straight line depreciation of investment method was used when calculating the annual loss from sedimentation. Benefits from the recommended program were determined by multiplying the difference in the annual rate of sediment accumulation, with and without remedial measures (expressed in acre feet), by the average per acre foot cost of storage, Table D-15. Storage costs for the Burton, Nacoochee, Mathis, Tallulah Falls, Tugaloo and Yonah Reservoirs were based on the estimated present replacement costs per installed kilowatt. The original costs of Issaqueena and Secession Lakes were brought up to current prices (1948) by using the Engineering News Record construction cost index.

1/ Effects of soil conservation on sedimentation in Lake Issaqueena, S. C., SCS-TP-95, June 1950.

It was assumed that replacement sites are available in all cases. This is a conservative method of determining replacement costs as almost invariably the best sites have already been utilized.

Silting of Public and Industrial Water Supply

There is a total of 42 water supply systems in the watershed. Twenty of these depend on drilled wells for water, two use water from springs, and twenty utilize surface water.

About 26 percent of the population depends on treated surface water for water supply. Almost 7.5 billion gallons of surface water were filtered in 1947. Records from all plants show a constantly increasing demand. A number of the filtering plants have inadequate capacities to meet present demand. Several new plants are under construction. Most of the filtering plants are supplied from retention reservoirs. These reservoirs are generally small and capable of storing from a few days' to two or three weeks' supply. The larger plants usually divert water directly from the stream channel by pumping or gravity flow.

The Augusta, Georgia, filtering plant, largest in the watershed, treated 3,850 million gallons during 1947. This plant utilizes water from the Savannah River. Completion of the Clark Hill Reservoir, 21 miles upstream, is expected to lower turbidities on the Savannah to a point where further reductions resulting from the recommended program will have only a limited beneficial effect. No benefits were claimed for turbidity reductions at this plant. The Thompson and Waynesboro, Georgia, filtering plants are located in the Coastal Plain Physical Land Unit. Turbidities at both plants were found to be below the desirable minimum during much of the year.

Water demand and cost figures from 17 plants were used when evaluating benefits from the recommended program. Reliable and comparable cost figures were difficult, often impossible to obtain. A number of the smaller plants had no cost accounting system. Estimates based on treatment costs of comparable plants were used where no cost figures were available.

Method of Calculation

The costs of treatment and benefits resulting from the recommended remedial measures are shown in Table D-18.

The steps used in the calculation are as follows:

1. Water treated annually (million gallons) X unit treatment cost per million gallons = annual cost of treatment without program.

2. Water treated annually X unit cost of treatment with program = annual cost of treatment with program.

3. Annual cost of treatment without program - annual cost of treatment with program = annual benefit.

Effect of the Recommended Program
On the Reduction of Sediment Damages

Accelerated runoff and soil erosion resulting from man's misuse of the land are the basic causes of sedimentation damages. The effectiveness of the recommended remedial measures will depend largely on the extent to which these measures reduce soil erosion and the volume and velocity of flood flows.

Sediment is produced principally by sheet erosion, gullying, road bank and stream bank erosion. Field studies in this watershed indicate that sheet erosion from sloping cultivated fields is the major sediment source. Coarse sediments from deep gullies and roadside ditches cause much of the stream channel fill.

The recommended program is expected to be most effective in the Piedmont Plateau Physical Land Unit. This area because of the high percentage of cultivated fields on sloping to steep land has the most serious erosion problem, and consequently produces the highest rates of runoff and sediment damage. Erosion and runoff control measures in this area will be more effective and have a wider application than in other parts of the watershed.

Deposition and scour damage are influenced to a great extent by the frequency and velocity of flood flows. Some damage will occur with almost every overflow. Only by keeping streams entirely within their banks can these damages be entirely eliminated.

Swamping is a product of channel fill. Measures to control gully and road bank erosion with channel improvement will do most to reduce this damage.

Detailed sedimentation surveys of High Point Reservoir, North Carolina, and Roxboro City Lake, North Carolina, both in the Piedmont Plateau, before and after conservation practices were put into effect, indicate that rates of reservoir silting can be reduced by about 35 percent by applying simple conservation practices on 20 percent of the watershed land 1/. Average rates of storage loss in Newnan Reservoir, Georgia, were reduced by 62 percent after soil and water conservation practices had been put into effect 2/.

The recommended program, by reducing stream turbidities, will result in a reduction in cost of water treatment. A large part of the damage to water supply is caused by sediments of colloidal size.

1/ Brune, Gunnar M., Effects of Soil Conservation on Reservoir Sedimentation in the Southeast, Jour. of Soil and Water Consv., Vol. 2, No. 2, April 1947.

2/ Brown, Carl B., Protecting Municipal Watersheds in Southeastern States. Public Works, Vol. 76, No. 5, May 1946.

Existing data indicate that about 90 percent of the fine suspended matter is a direct product of soil erosion. Except for very low turbidities, studies show a direct relationship between turbidity and the amount of chemicals needed for treatment 1/ . The largest saving will be in the use of chemicals, principally alum. Additional savings will be in labor and reduced filtering and wash water charges.

Previous studies show that a 10 percent saving will result from a program that is 25-30 percent effective in reducing sediment load 2/.

The estimated percent reductions of sedimentation damages resulting from the recommended program are given in the table below. These figures were used when calculating benefits from the recommended land treatment measures.

ESTIMATED REDUCTIONS OF SEDIMENT AND RELATED DAMAGES RESULTING FROM THE RECOMMENDED PROGRAM

Type of Damage	Percent Reductions	
	Mountain-Foothills	Piedmont Plateau
Silting of Reservoirs	45	70
Silting of Water Supply	15	15
Deposition of Infertile Sediments	60	65
Swamping	--	75
Scour	--	30

Other Direct Sedimentation Damages Not Evaluated Quantitatively

Sediment Damage to Drainage Enterprises

Organization of drainage districts began with the rise of farm commodity prices shortly prior to 1920. In 1940, there were 24 drainage enterprises in the watershed with an area of about 36,000 acres. Capital investment was more than $600,000 3/. Most of the drainage

1/ Brune, Gunnar M., Effects of Soil Conservation on Reservoir Sedimentation in the Southeast, Jour. of Soil and Water Consv., Vol. 2, No. 2, April 1947.

2/ Garin, Alexis N. and Forster, G. W. Effect of Soil Erosion on the costs of Public Water Supply. USDA, SCS-EC-1, July 1940.

3/ Drainage of Agricultural Lands, Sixteenth Census of the U. S. 1940. U. S. Dept. of Commerce, Bureau of the Census.

enterprises are in Banks and Franklin Counties, Georgia; and Anderson County, South Carolina.

Practically all drainage was accomplished by open ditches. In a few cases, maintenance work was done for two or three years following the original dredging. In most cases, however, provisions for maintenance were inadequate or entirely lacking. The cleared channels filled with sediment in from five to eight years after work on the channel was discontinued.

At the present time, the drainage districts are non-operative. The drainage channels are filled with sediment. Swamping of the adjacent flood plains, coupled with frequent overflow, has caused practically all lands in these projects to go out of agricultural use.

No benefit will be realized from protection of existing drainage channels since they are already filled with sediment. The recommended program will be of considerable benefit to any open ditch drainage work done in the future.

Sediment Damage to Navigation Channels

The entrance and lower 22 miles of the Savannah River have been improved to form Savannah Harbor. Above Savannah, the existing project provides for a channel 6 feet deep and 75 feet wide to mile 199 at Augusta, Georgia. There has been no commercial navigation on the river above Augusta since 1921.

The total cost of the Savannah Harbor project (new work and maintenance) to June 30, 1947, was more than $29,000,000. Total cost of the existing project above Savannah Harbor to June 30, 1947, was about $5,540,000 1/. During the period July 1, 1945 to June 30, 1946, 10,526,221 cubic yards of sediment were removed from Savannah Harbor and waterway at a cost of approximately $1,013,000. The following fiscal year, 5,602,845 cubic yards of sediment were removed at a cost of $657,896.

It is estimated that 40 percent of the material removed by dredging from Savannah Harbor and waterway is attributable to soil erosion.

The Clark Hill Reservoir, when completed, will trap most of the sediment produced in the watershed above the dam and is expected to reduce the cost of dredging in the lower Savannah River. Since most of the critically eroding part of the watershed is above the Clark Hill Reservoir, savings in dredging costs resulting from the recommended program will be relatively small. No benefit was claimed from this source.

1/ Report of the Chief of Engineers, U. S. Army. 1947 H. D. No. 457, Pt. 1, 80th Congress, 2nd Session.

Effect of Sediment on Aquatic Life

Present values of fish resources are low. Fish production is limited by long periods of turbid water, migrating sand bars, and the absence of gravel bottoms.

The principal species taken are catfish, crappie, and sunfish. Fishing conditions are generally better on the tributaries but are still greatly limited by high turbidities.

The Savannah River is not used by migratory fish. There is no commercial fishing of any importance.

Clearer water resulting from the recommended program will increase fish production by making conditions more favorable for the growth of fish food.

Effect of Sediment on Incidence of Malaria

The Department of Public Health, State of Georgia, reported very little malaria above the site of the Clark Hill Dam. Until recent years malaria has been a major public health problem from Augusta, Georgia, to Savannah, Georgia.

The State Board of Health of South Carolina in a letter dated December 8, 1948, reported the lowest incidence of malaria in the history of the state. Prevalence of this disease above Aiken, South Carolina, is practically nil. A few cases are reported from counties along the Savannah south of Aiken, South Carolina.

No dredging for malaria control has been done in the watershed for a number of years.

A reduction in the rate of sediment production will improve stream channel conditions. Drainage of flood plains will be improved and the possibility of a recurrence of the malaria problem will be reduced.

Effect of Sediment on Recreational Values

The Savannah River is not used to any great extent for recreational purposes except in the mountain tributaries. High turbidities during most of the year make the river unattractive for swimming. Reduction of stream turbidities resulting from the recommended program will increase recreational attendance at public parks and other recreational areas. Concession receipts, license fees, and other recreational revenue will be increased.

Sediment Damage to Property

Sediment increases the total property damage caused by flood waters. It complicates and adds to the cost of cleaning up after floods subside. This type of damage will be lessened with a decrease in the

amount of silt carried by flood waters.

Benefits From Increased Productivity of Bottom Lands

Tributary channel improvement measures in the Piedmont Plateau will bring into more productive agricultural use approximately 40,180 acres. It is that part of Land Capability Classes II-w, III-w, and V-w land now producing only brushy swamp growth of little or no economic value.

The gain in production value was based on an average annual net return to the land less the annual equivalent of costs necessary to get the land ready for production. This amounts to $5.72 per acre and results in an annual benefit to channel improvement of $229,800.

Ground Water

Thus far little consideration and no detailed study has been made to the benefits of ground water supply by increasing ground water recharge. There is direct evidence to show that ground water supplies have been augmented by increasing the amount of recharge in other sections of the country. Improved use and treatment of the land should be given more consideration as a factor which may serve to increase the ground water supply along with soil conservation and flood control benefits.

SUMMARY OF DAMAGES AND FLOOD CONTROL BENEFITS

All flood water and sedimentation damages and damage reductions evaluated monetarily are summarized in Table D-17. The damages that occur as a result of deposition and swamping amount to 15.3 percent of the total estimated damages. The greatest damages are to crops and pasture. These damages amount to 35.9 percent of the total damages. Anticipated reductions of all damages range from 43.5 percent in the Mountain-Foothill Physical Land Unit to 46.0 percent in the Piedmont Plateau Physical Land Unit.

PART II - COSTS AND CONSERVATION BENEFITS OF THE WATERSHED TREATMENT PROGRAM

GENERAL

Appraisal of the effects of the recommended program include certain associated benefits as well as the benefits from reduced flood damages mentioned in Part I. Associated benefits accrue to property owners and operators and to the public. They are the result of the open farm land treatment measures, the reduction in maintenance costs of railroads and public roads due to erosion control, and the increased returns from woodlands as a result of fire control and better management.

As implied previously under the heading FLOOD WATER AND SEDIMENT DAMAGES AND BENEFITS, the recommended program will also reduce flood volume and peak discharge thereby bringing about better regulation of stream flow and reduction of flood crests. The area inundated by present floods of various magnitudes would be reduced on the tributaries and upper reaches of the main stream. The rate of accelerated sheet and gully erosion will be greatly reduced.

The major land use changes recommended will result in conversion of most of the idle and the steep, eroded, cultivated lands to pasture, perennial legumes and grasses for hay or grazing, or to woodland. In order to accomplish these land conversions it will be necessary to make some reduction in the acreage of clean tilled row crops, principally corn and cotton. Additional acreages of feed and grazing crops will permit some expansion in livestock production.

Calendar year average prices received and paid (applicable to the watershed) by farmers for 1947 were used in estimating benefits and costs of open land measures. These prices are itemized in Tables D-18 and D-19.

COSTS

Cost of production data was summarized for each crop by operations. It was expected that changes would occur in the cost of normal operation of farms due to the recommended program. Certain operations, such as planting and fertilizing row crops, are not expected to change due to the recommended program. Other items, such as cost of harvest, change if there is a change in yield. Crop yields affected by the recommended program are shown by physical land units and their subdivisions in Table D-20.

The estimated cost of producing each crop per acre, present and future, is shown in Table D-21. Unit costs of land treatment and other measures are discussed in Appendix E.

Normal Farm Operation Costs

The effect of the total watershed treatment program on the cost of normal farm operation by physical land units and their subdivisions is shown by crops in Table D-22. The net changes in costs of normal farm operations, summarized by physical land units, are as follows:

Physical Land Unit	Increases in Costs
	Dollars
Mountain-Foothills	786,000
Piedmont Plateau	9,605,800
Total Watershed	10,391,800

As will be noted in Table D-22, there are no net decreases in the cost of producing crops by physical land units or their subdivisions. Decreased costs occurred for some individual crops.

Cost of the Recommended Program

The recommended program is determined by subtracting the expected physical accomplishment of "going" programs from the total watershed treatment program. See Appendix E. All direct costs of the recommended program by measures and services are shown in Table D-23. Indirect costs of the recommended program (such as increased costs of normal farm operations due to increased acreages of cover crops, increased harvest costs due to increased yields, etc.) are not included in this table. The direct costs of the recommended program are also shown broken down between Federal, non-Federal Public and Private sources.

Costs of Woodland Measures

The costs of the woodland phase of the recommended program will be incurred for five measures: (1) adequate fire protection, (2) tree planting for cover restoration on openland and interplanting of inadequately stocked woodland, (3) cover improvement, privately owned woodlands, (4) public acquisition of watershed lands, and (5) development and management of lands to be acquired (see tables D-23 and D-29). They are described in detail in appendix E.

In addition, for purposes of evaluation, there is the increased cost of timber production. This is incidental to the program and is simply the increased cost of producing greater future yields of timber. It is based on an estimated production cost of about $28.00 per thousand board feet, including woods and mill labor, hauling, and mill operation. The annual increased production cost is estimated to be $19,108,400 (see Table D-28). Of this amount, $9,716,600

is chargeable to the recommended program.

Cost of Tributary Channel Improvement and Stream Bank Stabilization

The cost of tributary channel improvement and stream bank stabilization was computed on a per stream mile basis. A detailed discussion of this item may be found in Appendix E. The total cost of installing these measures and the average annual cost of both installation and maintenance chargeable to Federal, non-Federal Public and Private sources are shown in Table D-24. Table D-23 shows the total costs and the number of miles needing treatment.

ASSOCIATED BENEFITS

Open Land Conservation Benefits

Open land conservation benefits are principally benefits to farmers due to increased farm income. They also include benefits due to reduction in maintenance costs of railroads and public roads.

Estimated changes in crop and pasture yields due to the watershed treatment program (total watershed needs) are shown in Table D-20. The estimated gross farm income per acre from each crop and from pasture is shown in Table D-25. The effect of the total watershed treatment program, including "going" programs, on gross farm income is shown in Table D-26 by physical land units and their subdivisions. The net changes in farm income summarized by physical land units are as follows:

Physical Land Unit	Increases in Farm Income
	Dollars
Mountain-Foothills	3,383,700
Piedmont Plateau	33,851,300
Total Watershed	37,235,000

There are no net decreases in gross farm income by physical land units or their subdivisions, although there were a few individual crops where decreases in gross income occurred. This is shown in Table D-26.

Annual conservation benefits from reduction of public road and railroad maintenance due to erosion control are shown in Table D-27. These benefits amount to $272,300.

Benefits from Woodland Measures

The major benefits from good timber management which accrue to woodland owners and operators are indicated by the increased yields to be obtained when the forest lands become fully stocked. Although many of the larger operators in the watershed market their forest products in a finished form such as dressed lumber, pulp, paper, or furniture, the benefits to average owners and operators are best appraised in terms of green lumber values and the value of pulpwood loaded at the railroad siding.

Present timber resources of the Piedmont and Mountain-Foothill portions of the watershed are badly depleted, the stands averaging only 1,895 board feet of sawtimber and 690 cubic feet of total merchantable volume per acre. With a current growth rate of slightly over $5\frac{1}{2}$ percent, the present annual yield of forest products is only 38 cubic feet per acre. With recommended woodland practices in effect, the effective growing stock will be increased to $2\frac{1}{2}$ times the present average volume. Cultural and protective practices will more than offset the tendency toward decreased growth percent often associated with heavier stocking. When the program becomes fully effective, annual production will average 95 cubic feet per acre.

Recognizing the growth and importance of the pulpwood using industries of the watershed, it is expected that one-third of the annual cut will be diverted into these channels, the other two-thirds going into sawtimber or other products of equivalent value. On this basis the present gross value of the annual growth is estimated to be $8.50 per acre. This will increase to $21.25 per acre when the program becomes fully effective. 1/

Table D-28 shows timber production returns at present and with the "going" and recommended programs combined. Increased annual production costs of $19,108,400 and increased gross annual returns of $35,353,600 will result from improved timber management, protection, and reforestation.

1/ Weighted values based on present and anticipated future distribution of wood products derived from annual growth.

PART III - SUMMARY AND COMPARISON OF BENEFITS AND COSTS OF THE RECOMMENDED PROGRAM

ADJUSTMENT FOR FUTURE FLOODWATER DAMAGES

The area of land in agricultural production subject to flood damages diminishes until the program stabilizes land damages. The following procedure was used to make the adjustment.

It was assumed that floodwater damage would decrease in a ratio directly proportional to the decrease in the number of damageable acres. It was also assumed that land damage, expressed as a net loss in productivity of the land, would increase for 100 years for the Mountain-Foothills Area and 50 years for the Piedmont Plateau. Land damage would then become constant with no further increase. The floodwater damage would decrease for a like number of years and then become constant with no further decreases. The calculations based on these assumptions are shown below.

Without Program

Mountain and Foothills Physical Land Unit:

Initial annual floodwater damage to crops and pasture	$210,800	
Annual floodwater damage at 100th year	206,370	1/
Decrease in annual damage	$ 4,430	
Annual decrease in damage during 100 years	$ 44	

$$44 \times 1887.376^{2/} + \frac{206,370}{0.04} = \$5,242,295$$

Annual equivalent floodwater damage = $5,242,295 x 0.04 = $209,692

Land damage (average annual equivalent of loss) = 3,600

Total annual damage = $213,292

Piedmont Physical Land Unit:

Initial annual floodwater damage to crops and pasture	$383,300	
Annual floodwater damage at 50th year	311,815	1/
Decrease in annual damage	$ 71,485	
Annual decrease in damage (50-year period)	1,430	

$$1,430 \times 712.94538^{3/} + \frac{311,815}{0.04} = \$8,814,887$$

Annual equivalent floodwater damage = $8,814,887 x 0.04 =	352,595
Land damage (average annual equivalent of loss) =	250,400
Total annual damage =	$602,995

1/ Annual loss in floodable acres = 0.021 percent.
2/ Present value of annuity decreasing by 1 per year for 100 years at 4%
3/ Present value of annuity decreasing by 1 per year for 50 years at 4%

Adjustment for Future Floodwater Damages

With Channel Improvement Only: 1/

Initial annual floodwater damage to crops and pasture	$460,100
Annual floodwater damage at 100th year	362,007 2/
Decrease in annual damage	$ 98,093
Annual decrease in damage during 100 years	$ 931

$931 \times 1887.376\ 3/ + \frac{362,007}{0.04} = 1,851,516 + 9,050,175 =$ $10,901,691

Annual equivalent of floodwater damage = $10,901,691 x 0.04 = 436,068

Land damage (average annual equivalent of loss) = 216,400

Total annual damage = $652,468

With Complete Program: 1/

Initial annual floodwater damage to crops and pasture	$261,500
Annual floodwater damage at 100th year	$242,149 4/
Decrease in annual damage	$ 19,351
Annual decrease in damage during 100 years	$ 194

$194 \times 1887.376\ 3/ + \frac{242,149}{0.04} = 366,151 + 6,053,725 =$ $6,419,876

Annual equivalent of floodwater damage = 6,419,876 x 0.04 = 256,795

Land damage (average annual equivalent of loss) = 74,500

Total annual damage = $331,295

Agricultural and Land Damage Reductions:

Annual Equivalent of Floodwater and Land Damage Without Program	$816,287
Annual Equivalent of Floodwater and Land Damage with Channel Improvement Only	$652,468
Annual Equivalent of Floodwater and Land Damage with Complete Program	$331,295

$816,287 - $652,468 = $163,800 5/	Agricultural and Land Damage Reductions from Channel Improvement.
$816,287 - $331,295 = $485,000 5/	Agricultural and Land Damage Total Reductions
$485,000 - $163,800 = $321,200	Agricultural and Land Damage Reductions from Other Measures.

1/ Mountain-Foothills and Piedmont Physical Land Units combined.
2/ Annual loss in floodable acres = 0.2132 percent.
3/ Present value of annuity decreasing by 1 per year for 100 years at 4%.
4/ Annual loss in floodable acres = 0.0740 percent.
5/ Rounded to the nearest 100.

ADJUSTMENT OF COSTS AND BENEFITS FOR "GOING" PROGRAMS

A proportion of the increases in annual open land and woodland production costs is assignable to "going" programs. The ratio of the annual equivalent direct costs of the "going" programs to the recommended program is the method of division. This ratio is determined on a percentage basis. All benefits to land treatment measures are divided between "going" programs and the recommended program in proportion to the costs of each phase.

A much larger proportion of the land treatment phase of the program will be accomplished under the "going" programs on open land than on forest land. Separate estimates of the costs and benefits from woodland and open land are calculated on the basis of the annual equivalent costs 1/. A separate ratio is determined for woodland and open land in the following summary.

Woodland Treatment Measures:

Annual Equivalent Costs "Going" Program	$520,700
Annual Equivalent Costs Recommended Program 2/	$538,700
Total	$1,059,400

$\frac{538,700}{1,059,400}$ = 50.85% due to Recommended Program

$35,353,600 Annual Woodland Benefits (Page D-21)
50.85%
$17,977,300 Woodland Benefits from Recommended Program

$19,108,400 Total Increase in Annual Production Costs on Woodland (Page D-21)
50.85%
$ 9,716,600 Increase in Annual Woodland Production Costs due to Recommended Program

Open Land Treatment Measures:

Annual Equivalent Costs, "Going" Programs	$7,361,100
Annual Equivalent Costs, Recommended Program 2/	1,506,500
Total	$8,867,600

$\frac{\$1,506,500}{\$8,867,600}$ = 17.00% due to Recommended Program

$37,235,000 Open Land Conservation Benefits (Page D-20)
17.00%
$ 6,330,000 Open Land Conservation Benefits from Recommended Program

$10,391,800 Total Increase in Annual Production Costs on Open Land (Page D-19)
17.00%
$ 1,766,600 Increase in Annual Production Costs due to Recommended Program on Open Land.

1/ The average annual equivalent of installation costs was determined by taking 2½ percent of the Public and 4 percent of the Private installation costs. These totals were added to the annual maintenance costs.

2/ Includes prorated costs.

Benefits from Reduction in Flood Damages:

Benefits from reduction in flood damages due to conservation measures are attributable jointly to open land and woodland treatment measures. These benefits cannot be readily nor accurately separated according to open land or woodland measures. The proportioning of these benefits to the "going" and recommended programs can best be considered as a total rather than individually. The ratio between the direct annual equivalent costs of the total land treatment and the recommended program provides the basis for separating the benefits. It is computed as follows:

Total Land Treatment Program	
Annual Equivalent Costs "Going" Program	$[illegible],881,800
Annual Equivalent Costs Recommended Program 1/	2,045,200
Total	$9,927,000

$$\frac{\$2,045,200}{\$9,927,000} = 20.6\%$$ due to Recommended Program

Sources and amounts of these benefits including "going" and recommended programs are as follows:

Reduction in Flood Damages Due to Conservation Measures		
Agricultural and Land Damage	$321,200	(Page D-23)
Public Roads and Railroads	82,400	(Table D-9)
Reservoir Silting	93,[illegible]00	(Table D-15)
Water Supply Silting	23,600	(Table D-16)
Sub-total	$520,100	
	20.6%	
Due to Recommended Program	$1[illegible]	

1/ The average annual equivalent of installation costs was determined by taking 2½ percent of the Public and 4 percent of Private installation costs. Annual operation and maintenance costs were added to these to obtain total annual costs.

SUMMARY

Summary of Costs of the Recommended Program

All costs of the recommended program, except increases in annual costs of open land and woodland production, are shown in Table D-23 by measures. The following is a summary and distribution of the costs of the recommended program shown in Table D-30 by groups of measures and the annual increase in production costs on open land and woodland.

Total Installation Costs		
Federal	$14,378,400	
Non-Federal Public	2,854,300	
Private	4,873,300	
Total	$22,106,000	
Average Annual Equivalent of Installation Costs		
Federal	$ 359,500	
Non-Federal Public	71,400	
Private	194,900	
Sub-total		$ 625,800
Annual Direct Operation and Maintenance Costs		
Federal	$ 158,300	
Non-Federal Public	532,000	
Private	845,900	
Sub-total		$1,536,200
Total Annual Direct Costs of Program Measures		$2,162,000
Annual Increase in Production Costs on Open Land and Woodland		$11,483,200
Total Average Annual Costs		$13,645,200
Annual Direct Operation and Maintenance Costs	$1,536,200	
Annual Increase in Production Costs on Open Land and Woodland	$11,483,200	
Total Annual Operation and Maintenance Costs		$13,019,400

The average annual cost to channel improvement amounts to $116,800 (Tables D-24 and D-30) and is included in the preceding total average annual costs.

Allocation of the costs of the program to Federal, non-Federal Public, and Private source of funds is made according to the ratio that benefits are expected to accrue to each of these interests. Table D-23 shows the distribution of installation and maintenance costs of the recommended program by measures, groups of measures, and sources (Federal, non-Federal Public, and Private).

Benefits from Channel Improvement and Stream Bank Stabilization

Flood damage benefits from channel improvement and stream bank stabilization become fully effective immediately upon installation. Sources and amounts of benefits are estimated as follows:

Agricultural and Land Damage Reductions	$163,800	(Page D-23)
Benefits From Increased Productivity of Bottomlands	229,800	(Page D-17)
Total	$393,600	

Summary of Benefits of the Recommended Program

All benefits to land treatment measures are divided between "going" programs and the recommended program. The division of land treatment benefits was completed on Page 24.

Total flood control and conservation benefits from the recommended program are as follows:

Open Land Conservation	$6,330,000
Woodland Benefits	17,977,300
Flood Reduction Benefits	107,200
Decreased Maintenance of Roads and Railroads	272,300
Channel Improvement	393,600
Total	$25,080,400

COMPARISON OF BENEFITS AND COSTS OF THE RECOMMENDED PROGRAM

Comparison of Benefits and Costs - Channel Improvement Only

At the 1947 cost-price level, the total average annual benefits from channel improvement and stream bank stabilization amount to $393,600 and total average annual costs amount to $116,800.

These benefits and costs are adjusted to future price levels by indexes provided by the Bureau of Agricultural Economics as follows:

	1947 Indexes	Future Indexes	Base Period
Benefit Conversion Indexes			
Farm Product Prices 1/	266	130	(1910-14 = 100)
Items Used in Production	224	155	(1910-14 = 100)
Farm Wage Rates	419	275	(1910-14 = 100)
Cost Conversion Indexes			
Construction Costs	413	325	(1913 = 100)

1/ Weighted average index of major product groups found in the watershed.

Weighted conversion factors were determined from these indexes and are applied to benefits and costs for adjustment purposes to arrive at adjusted benefits and costs as follows: Benefits, $228,700; Costs, $91,900.

The adjusted channel improvement benefit-cost ratio is 2.49 to 1.

Comparison of Benefits and Costs - Recommended Program

At the 1947 cost-price level, the total average annual benefits from the recommended program (including channel improvement) amount to $25,080,400 and total average annual costs amount to $15,645,200.

These benefits and costs are adjusted to future price levels by indexes provided by the Bureau of Agricultural Economics as follows:

	1947 Indexes	Future Indexes	Base Period
Benefit Conversion Indexes			
Farm Product Prices 1/	266	130	(1910-14 = 100)
Wholesale Lumber	278	145	(1926 = 100)
Items Used in Production	224	155	(1910-14 = 100)
Farm Wage Rates	419	275	(1910-14 = 100)
Construction Costs	413	325	(1913 = 100)
Cost Conversion Indexes			
Farm Wage Rates	419	275	(1910-14 = 100)
Items Used in Production	224	155	(1910-14 = 100)
Construction Costs	413	325	(1913 = 100)

Indexes were weighted to reflect the amounts of benefits and costs coming from each source to which the index was applicable. The adjusted benefits amount to $12,851,200 and the adjusted costs amount to $9,475,200.

The adjusted recommended program benefit-cost ratio is 1.36 to 1.

NOTES ON THE DERIVATION OF CERTAIN DATA SHOWN IN THE SURVEY REPORT

The average annual flood control benefit of $313,000, shown in the report is a combination of the $393,600 benefit to channel improvement only (Tables D-8, D-13, and Page D-27) and the sum of other flood-control benefits (Page D-27) multiplied by 20.6 percent. The sum of other flood-control benefits, derived as described above and rounded to the nearest thousand dollars, is shown in Table D-31. Channel improvement benefits and associated benefits are also shown in Table D-31. These benefits were then adjusted by the use of future indexes furnished by the Bureau of Agricultural Economics, and the adjusted benefits are also shown in Table D-31. The individual weighted conversion factors are as follows: For channel improvement and other flood-control benefits, 0.581; all other flood-control and associated benefits, 0.511. Adjusted associated benefits were determined by subtracting adjusted flood-control benefits from adjusted total benefits.

1/ Weighted average index of major product groups found in the watershed.

Federal, non-Federal Public and Private costs of the recommended program are summarized in Table D-31. These costs after adjustment by a weighted future index (derived from future indexes furnished by the Bureau of Agricultural Economics) are also shown in Table D-31. The conversion factors in making cost adjustments shown in Table D-31 are: Channel improvement and all public costs, 0.737; private costs by a weighted factor of .686.

Comparison of the Effect of Discounting Delayed Benefits

There are certain types of benefits resulting from the recommended program that will be delayed until treatment measures become fully effective. In this analysis, therefore, such benefits were discounted to allow for this lag in effectiveness.

It was assumed that benefits resulting from land treatment measures, namely, floodwater damage reductions, open land conservation benefits, and decreased cost of maintenance on roads and railroads, would be delayed 5 years, and that woodland conservation benefits would be delayed 50 years. It was also assumed that each type of benefit would start at zero and uniformly build up to the maximum over the period of delay. The benefits would then level off and remain constant thereafter.

Increases in annual costs of open land and woodland production were discounted in the same manner as described for benefits. Other costs were not discounted.

Benefits resulting from the channel improvement measure will become fully effective immediately upon installation and, therefore, were not discounted.

Discounting deferred benefits from land treatment measures will reduce the ratio of total benefits to total costs for all measures from 1.36 to 1 to 1.31 to 1.

The recommended program described and evaluated in these appendixes includes forest land management measures for 2,701,000 acres, the area which should be treated to achieve the most effective program of runoff and water flow retardation and soil erosion prevention. An evaluation of the progress of the going program as it is now operating and as it is affected by the lack of some form of public control of forest practices on private land indicates that this full treatment will not be fully attained during the 15-year installation period.

In order to make the program consistent with these indications, the recommendations presented in the report include forest land measures for only the area on which it is estimated these measures will be adequately maintained. The quantities of forest measures recommended in the report were obtained by reducing those shown for private forest land in the appendixes, the reductions being made both in the areas to be treated and in cost of treatment. The recommended forest land measures now include cover improvement for 1,095,000 acres of private forest land at an estimated installation cost of $408,500 to the Federal Government and $408,500 to local interests. The revised estimates of annual operation and maintainance costs of this measure are $27,230 to the Federal Government and $27,230 to local interests. Tree planting was also revised and is now recommended on 111,400 acres of private lands at an estimated installation cost of $454,000 to the Federal Government and $1,362,000 to local interests. These changes resulted in a reduction of 9 percent in the average annual cost of forest land measures.

Benefits and increased production costs resulting from forest measures were reduced in proportion to the reduction in cost of these measures. This resulted in the following changes:

1. Total flood control benefits, shown on page 25, Appendix D, were reduced from $107,200 to $104,600.

2. Total forest conservation benefits, shown on page 24, Appendix D, were reduced from $17,977,300 to $16,359,300.

3. Increased forest production costs, shown on page 24, Appendix D, were reduced from $9,716,600 to $8,842,100.

The net effect on the annual costs and benefits of the land treatment measures (1947 prices) was to change total annual costs from $13,528,400 to $12,605,400, and annual benefits from $24,686,800 to $23,066,200. Total costs and benefits based on 1955-1965 prices changed respectively from $9,475,200 to $8,838,400 and $12,851,200 to $12,022,900. These revisions did not change the benefit-cost ratio of 1.36 to 1.

Table D-1

AVERAGE DAMAGEABLE VALUES PER ACRE BY MONTHS AND BY CROPS 1/
BROAD RIVER, GEORGIA
SAVANNAH RIVER WATERSHED

Crop	Value of Crop by Months in Dollars											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Corn	--	--	--	4.90	14.40	22.40	27.40	29.30	22.30	12.20	4.40	--
Oat Hay	17.20	18.00	20.20	22.40	11.40	--	--	--	2.30	8.00	11.60	16.60
Lespedeza Hay	--	--	2.40	5.20	5.80	6.50	36.60	18.40	--	--	--	--
Meadow Hay	--	--	9.50	10.10	10.80	11.40	12.00	6.20	--	--	--	--
Pasture	--	--	--	.30	.60	.60	.60	.50	.50	.50	.20	--

1/ Based on 1947 prices and costs.

Table D-2

DAMAGEABLE VALUES OF A COMPOSITE ACRE
OF OPEN FLOOD PLAIN LAND BY MONTHS AND BY CROPS 1/
BROAD RIVER, GEORGIA
SAVANNAH RIVER WATERSHED

Land Use	Weighted Average Damageable Values in Dollars											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Corn	--	--	--	1.57	4.61	7.17	8.77	9.38	7.14	3.90	1.41	--
Oat Hay	.52	.54	.61	.67	.34	--	--	--	.07	.24	.35	.50
Lespedeza Hay	--	--	.07	.16	.17	.20	1.10	.55	--	--	--	--
Meadow Hay	--	--	2.09	2.22	2.58	2.51	2.64	1.36	--	--	--	--
Pasture	--	--	--	.05	.10	.10	.10	.08	.08	.08	.03	--
Idle	--	--	--	--	--	--	--	--	--	--	--	--
Total Value of Composite Acre	.52	.54	2.77	4.67	7.60	9.98	12.61	11.37	7.29	4.22	1.79	.50

1/ Based on 1947 prices and costs.

Table D-3

ESTIMATED PERCENT DAMAGE BY DEPTHS OF INUNDATION
BY MONTHS, FOR CORN - BROAD RIVER, GEORGIA
SAVANNAH RIVER WATERSHED 1/

Depth Inundation in Feet	Percent Damage by Months											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	--	--	--	50	75	10	--	--	--	--	--	--
2	--	--	--	75	90	50	10	10	10	10	10	--
3	--	--	--	100	100	90	50	50	50	50	50	--
4	--	--	--	100	100	100	80	80	80	80	80	--
5	--	--	--	100	100	100	100	100	100	100	100	--
6	--	--	--	100	100	100	100	100	100	100	100	--

1/ Similar estimates were made for each crop in the flood plain.

Table D-4

ESTIMATED DAMAGE PER ACRE OF OPEN FLOOD PLAIN LAND
BY DEPTHS OF INUNDATION BY MONTHS FOR CORN
BROAD RIVER SAMPLE TRIBUTARY
SAVANNAH RIVER WATERSHED 1/

Depth Inundation in Feet	Damage to Corn by Months in Dollars 2/											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	--	--	--	0.78	3.46	0.72	--	--	--	--	--	--
2	--	--	--	1.18	4.15	3.58	0.88	0.94	0.71	0.39	0.14	--
3	--	--	--	1.57	4.61	6.45	4.58	4.69	3.57	1.95	0.70	--
4	--	--	--	1.57	4.61	7.17	7.02	7.50	5.71	3.12	1.13	--
5	--	--	--	1.57	4.61	7.17	8.77	9.38	7.14	3.90	1.41	--
6	--	--	--	1.57	4.61	7.17	8.77	9.38	7.14	3.90	1.41	--

1/ Similar estimates were made for each crop in the flood plain.
2/ Based on 1947 prices and costs.

Table D-5

FLOOD DAMAGES TO CROPS AND PASTURE
PER ACRE OF OPEN FLOOD PLAIN LAND
BY MONTHS AND BY DEPTHS OF INUNDATION 1/
BROAD RIVER SAMPLE TRIBUTARY, GEORGIA
SAVANNAH RIVER WATERSHED

Depth Inundation in Feet	Weighted Average Damage Per Acre of Open Flood Plain Land by Months											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	$	$	$	$	$	$	$	$	$	$	$	$
1	0.10	0.10	0.40	1.60	4.00	1.00	2.40	2.00	0.10	0.20	0.10	0.10
2	0.10	0.10	0.40	2.00	4.70	4.00	4.60	2.90	0.80	0.60	0.30	0.10
3	0.10	0.10	0.40	2.40	5.20	7.90	8.20	6.60	3.70	2.10	0.80	0.10
4	0.10	0.10	0.40	2.40	5.30	8.70	10.80	9.40	5.80	3.30	1.20	0.10
5	0.10	0.10	0.40	2.40	5.30	8.70	12.60	11.30	7.30	4.10	1.50	0.10
6	0.10	0.10	0.40	2.40	5.30	8.70	12.60	11.30	7.30	4.10	1.50	0.10

1/ Based on 1947 prices and costs.

Table D-6

STAGE AREA RELATIONSHIPS PER STREAM MILE
BY ONE-FOOT DEPTH OF INUNDATION INTERVALS
BROAD RIVER, GEORGIA
SAVANNAH RIVER WATERSHED

Stage in Feet	Acres Inundated by One-Foot Depth of Inundation Intervals							Total Acres Inundated
	0-1	1-2	2-3	3-4	4-5	5-6	6-7 and up	
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	4.8	0.0	0.0	0.0	0.0	0.0	0.0	4.8
17	4.0	4.8	0.0	0.0	0.0	0.0	0.0	8.8
18	5.1	4.0	4.8	0.0	0.0	0.0	0.0	13.9
19	5.1	5.1	4.0	4.8	0.0	0.0	0.0	19.0
20	3.7	5.1	5.1	4.0	4.8	0.0	0.0	22.7
21	3.9	3.7	5.1	5.1	4.0	4.8	0.0	26.6
22	4.2	3.9	3.7	5.1	5.1	4.0	4.8	30.8
23	4.0	4.2	3.9	3.7	5.1	5.1	8.8	34.8
24	4.0	4.0	4.2	3.9	3.7	5.1	13.9	38.8
25	1.2	4.0	4.0	4.2	3.9	3.7	19.0	40.0
26	1.4	1.2	4.0	4.0	4.2	3.9	22.7	41.4
27	1.4	1.4	1.2	4.0	4.0	4.2	26.6	42.8
28	1.2	1.4	1.4	1.2	4.0	4.0	30.8	44.0
29	1.2	1.2	1.4	1.4	1.2	4.0	34.8	45.2
30	4.2	1.2	1.2	1.4	1.4	1.2	38.8	49.4
31	3.5	4.2	1.2	1.2	1.4	1.4	40.0	52.9
32	3.6	3.5	4.2	1.2	1.2	1.4	41.4	56.5
33	3.4	3.6	3.5	4.2	1.2	1.2	42.8	59.9
34	3.5	3.4	3.6	3.5	4.2	1.2	44.0	63.4
34.8	2.9	3.5	3.4	3.6	3.5	4.2	45.2	66.3

Table D-6

Table D-7

STAGE-DAMAGE RELATIONSHIPS BY MONTHS PER STREAM MILE 1/
BROAD RIVER FLOOD PLAIN
SAVANNAH RIVER WATERSHED

Peak Stage in Feet 2/	Damage to Fixed Improvements 3/ Dollars	Damage to Crops and Pasture - Nearest Dollar									
		Dec. Jan. Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
16	0	0	2	8	19	5	12	10	0	1	0
17	1	1	4	16	39	23	32	22	4	4	2
18	2	1	6	28	64	59	70	53	21	14	6
19	3	2	8	39	91	99	120	97	47	28	11
20	4	2	9	49	112	141	178	148	82	47	18
21	6	3	11	59	133	180	234	200	116	67	25
22	7	3	12	69	155	214	289	249	148	85	32
23	9	4	14	79	176	249	340	295	178	102	38
24	11	4	16	88	198	285	391	340	207	118	44
25	12	4	16	93	208	317	435	380	237	134	49
26	14	4	17	98	216	341	473	413	264	149	55
27	15	4	17	101	224	354	501	446	283	160	59
28	16	4	18	104	231	366	523	465	297	167	61
29	16	4	18	107	237	377	539	480	306	173	63
30	17	5	20	115	256	391	562	501	316	178	66
31	18	5	21	122	273	413	590	522	328	185	68
32	19	6	23	131	292	444	627	554	347	196	72
33	20	6	24	140	311	475	663	591	370	209	77
34	21	6	25	148	329	506	714	632	397	224	83
34.8	22	7	26	155	345	535	756	670	423	239	88

1/ 1947 cost-price level.
2/ Stage in feet on the Broad River gage near Bell, Georgia.
3/ Variation in damages to fixed improvements by months is negligible.

Table D-8

AGRICULTURAL DAMAGES AND BENEFITS 1/
AVERAGE ANNUAL FLOOD DAMAGES AND FLOOD REDUCTION BENEFITS
SAVANNAH RIVER WATERSHED

Sample	Stream Miles Represented	Present Damages		Future Damages				Benefits		
		Per Stream Mile	Total	With Channel Improvement		With Complete Program		Channel Improv. Benefits	Other Benefits	Total Benefits
				Per Stream Mile	Total	Per Stream Mile	Total			
	Miles	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Keowee River, S. C. for Mountain-Foothills	620	340	210,800	[illegible]	173,600	153	94,900	37,200	78,700	115,900
Broad River, Georgia	201	185	37,200	[illegible]	30,200	84	16,900	7,000	13,300	20,300
Little River, S. C.	1,871	185	346,100	[illegible]	256,300	80	149,700	89,800	106,600	196,400
Total for Piedmont	2,072		383,300		286,500		166,600	96,800	119,900	216,700
Savannah River Watershed Total	2,692		594,100		460,100		261,500	134,000	198,600	332,600

1/ Includes crop and pasture damages and damages to fixed improvements.

Table D-9

SUMMARY OF FLOOD DAMAGES AND BENEFITS ON PUBLIC ROADS AND RAILROADS - SAVANNAH RIVER WATERSHED

Area	Estimated Annual Damages		Annual Benefits
	Present	Future	
	Dollars	Dollars	Dollars
Mountain-Foothills	62,300	49,900	12,400
Piedmont Plateau	350,000	280,000	70,000
Coastal Plain	68,500	68,500	--
Total	480,800	398,400	82,400

Physical Land Unit	Sample Tributaries	Tot In		Total	Swamping	
			$	$	Acres	$
Mountain-Foothills	Keowee River	3			0	
Piedmont Plateau	Broad River	7	224.40	289.30	2,673	26,195.40
Piedmont Plateau	Little River	1		0.00	1,454	14,249.20

Table D-10

TOTAL NET LOSS FROM SEDIMENT DAMAGE TO FLOOD PLAINS, SAMPLE TRIBUTARIES
SAVANNAH RIVER WATERSHED

Physical Land Unit	Sample Tributaries	Total Acres In Sample	Deposition of Infertile Sediment							Scour					Swamping	
			1		2		3		Total	1		2		Total		
			Acres	$	Acres	$	Acres	$	$	Acres	$	Acres	$	$	Acres	$
Mountain-Foothills	Keowee River	3,055	0		163	1,434.40	0		1,434.40	0		0			0	
Piedmont Plateau	Broad River	7,319	145	319.00	326	1,434.40	0		1,753.40	118	64.90	204	224.40	289.30	2,673	26,195.40
Piedmont Plateau	Little River	1,842	0		0		0		0.00	0		0		0.00	1,454	14,249.20

Physical Land Unit	Sample Tributaries	ss I F wamping	Annual Per Acre Increment of Loss		
			Deposition	Scour	Swamping
		Dollars	Dollars	Dollars	Dollars
Mountain-Foothills	Keowee River	0.00	.0046	.0000	.0000
Piedmont Plateau	Broad River	231.82	.0021	.0003	.0317
Piedmont Plateau	Little River	126.10	.0000	.0000	.0685

Table D-11

ANNUAL INCREMENT OF FLOOD PLAIN LOSS, SAMPLE TRIBUTARIES
SAVANNAH RIVER WATERSHED

Physical Land Unit	Sample Tributaries	Total Acres In Sample Flood Plain	Cumulative Production Loss			Period During Which Loss Occurred	Annual Increment of Loss			Annual Per Acre Increment of Loss		
			Deposition	Scour	Swamping		Deposition	Scour	Swamping	Deposition	Scour	Swamping
			Dollars	Dollars	Dollars	Years	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Mountain-Foothills	Keowee River	3,055	1,434.40	0.00	0.00	101	14.20	0.00	0.00	.0046	.0000	.0000
Piedmont Plateau	Broad River	7,319	1,753.40	289.30	26,195.40	113	15.52	2.56	231.82	.0021	.0003	.0317
Piedmont Plateau	Little River	1,842	0.00	0.00	14,249.20	113	0.00	0.00	126.10	.0000	.0000	.0685

Physical Land Unit	Sample Tributaries	amping re rs	 Total Dollars	Total Annual Increment of Loss Dollars 2/
Mountain-Foothills	Keowee River	00	0.00	145
Piedmont Plateau	Broad River	17	6,615.69	7,117
Piedmont Plateau	Little River	35	4,539.22	4,539
Piedmont Plateau Sub-Total			11,154.91	11,656
Grand Total				11,801

1/ Does not include Area of Bottom Land flo

2/ Rounded to nearest dollar.

Table D-12

ANNUAL INCREMENT OF FLOOD PLAIN LOSS, ENTIRE WATERSHED
SAVANNAH RIVER WATERSHED

Physical Land Unit	Sample Tributaries	Total Flood Plain Area	Annual Increment of Loss						Total Annual Increment of Loss
			Deposition		Scour		Swamping		
			Per Acre	Total	Per Acre	Total	Per Acre	Total	
		Acres	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars 2/
Mountain-Foothills	Keowee River	31,458	.0046	144.71	.0000	0.00	.0000	0.00	145
Piedmont Plateau	Broad River	208,697	.0021	438.26	.0003	62.61	.0317	6,615.69	7,117
Piedmont Plateau	Little River	66,266	.0000	0.00	.0000	0.00	.0685	4,539.22	4,539
Piedmont Plateau Sub-Total	-	274,963 1/		438.26		62.61		11,154.91	11,656
Grand Total									11,801

1/ Does not include Area of Bottom Land flooded by Clark Hill Reservoir.

2/ Rounded to nearest dollar.

Table D-13

Physical Land Unit	Type of Damage	Average Annual Benefit[2]		
		From Channel Improvement	From Other Measures	Total
		Dollars	Dollars	Dollars
Mountain-Foothills	Deposition	700	1,500	2,200
Piedmont Plateau	Deposition	1,400	4,300	5,700
	Scour	200	100	300
	Swamping	35,300	136,000	171,300
Watershed Total		37,600	141,900	179,500

1/ Rounded to nearest dollar.
2/ Rounded to nearest hundred do

Table D-13

FLOOD PLAIN LOSSES AND BENEFIT FROM RECOMMENDED REMEDIAL MEASURES
SAVANNAH R VER WATERSHED

Physical Land Unit	Type of Damage	Average Annual Increment of Loss 1/			Average Annual Equivalent of Loss 2/			Average Annual Benefit 2/		
		Without Program	With Channel Improvement	With Complete Program	Without Program	With Channel Improvement	With Complete Program	From Channel Improvement	From Other Measures	Total
		Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Mountain-Foothills	Deposition	145	119	58	3,600	2,900	1,400	700	1,500	2,200
Piedmont Plateau	Deposition	438	327	153	9,400	8,000	3,700	1,400	4,300	5,700
	Scour	63	47	44	1,400	1,200	1,100	200	100	300
	Swamping	11,155	8,338	2,789	239,600	204,300	68,300	36,300	136,000	171,300
Watershed Total					[illegible],000	216,400	74,500	37,600	141,900	179,500

1/ Rounded to nearest dollar.
2/ Rounded to nearest hundred dollars.

Table D-14

LIST OF RESERVOIRS
SAVANNAH RIVER WATERSHED

Physical Land Unit	Reservoir Name And/Or Owner	Stream	Original Storage Capacity	Principal Use	Primary Purpose	Remarks
			Acre-Feet			
Mountain-Foothills	Burton	Tallulah River	110,000	Power	Retention	4/
	Mathis	Tallulah River	31,400	Power	Retention	4/
	Nacoochee	Tallulah River	1,450	Power	Retention	4/
	Russell	Nancytown Creek	2,800	Recreation	Retention	2/
	Tallulah Falls	Tallulah River	20,000	Power	Retention	4/
	Tugaloo	Tugaloo River	11,500	Power	Retention	4/
	Yonah	Tugaloo River	3,340	Power	Retention	4/
Piedmont Plateau	Augusta City	Savannah River	Small	Power	Head	1/
	Clark Hill	Savannah River	2,900,000	Multi-Purpose	Retention	4/
	Cregg Shoals	Savannah River	Small	Power	Head	1/
	Issaqueena	Six Mile Creek	1,836	Recreation	Retention	4/
	Louise	Walton Creek	Small	Water Supply	Retention	3/
	Newry	Little River	Small	Power	Head	1/
	Portman Shoals	Seneca River	Small	Power	Head	1/
	Secession	Rocky River	25,650	Power	Retention	4/
	Stevens Creek	Savannah River	12,300	Power	Head	1/
Coastal Plain	Graniteville	Horse Creek	300	Power	Retention	2/ 3/
	Langley	Horse Creek	900	Power	Retention	2/ 3/

1/ Filled to normal channel capacity.
2/ Low rate of silting.
3/ Small initial investment.
4/ Will be benefited by program.

Physical Land Unit	Reservoir	Dra Tot	st Per re Ft. orage	Annual Loss Without Program	Annual Loss With Program	Annual Benefit
		Sq. M	ollars	Dollars	Dollars	Dollars
Mountain-Foothills	Burton	11	66	1,518	835	683
	Nacoochee	13	1,960	3,920	2,156	1,764
	Mathis	15	257	1,285	707	578
	Tallulah Falls	18	846	5,922	3,257	2,665
	Tugaloo	46	1,068	64,080	35,244	28,836
	Yonah	47	[illegible],661	26,610	14,635	11,975
	Sub-Total			103,335	56,834	46,501
Piedmont Plateau	Clark Hill	6,144	17	56,712	[illegible]7,014	39,698
	Issaqueena	14	115	1,955	587	1,368
	Secession	196	44	8,008	2,402	5,606
	Sub-Total			66,675	20,003	46,672
	Grand Total			170,010	76,837	93,173

1/ Net Drainage Area below other

2/ Estimated total present (1948)

Table D-15

BENEFITS FROM REDUCTION OF RESERVOIR SEDIMENTATION
SAVANNAH RIVER WATERSHED

Physical Land Unit	Reservoir	Drainage Area Total	Drainage Area Net 1/	Original Storage Capacity	Capacity Water-shed Ratio	Estimated Trap Efficiency	Original Cost	Cost 2/ (1948 prices)	Ann. Rate Sed. Prod. Per Sq. Mi. Net Area	Annual Storage Loss	Cost Per Acre Ft. Storage	Annual Loss Without Program	Annual Loss With Program	Annual Benefit
		Sq. Mi.	Sq. Mi.	Acre-Ft.		Percent		Dollars	Acre-Ft.	Acre-Ft.	Dollars	Dollars	Dollars	Dollars
Mountain-Foothills	Burton	118	118	110,000	932	98		7,221,600	0.2	23	66	1,518	835	683
	Nacoochee	136	18	1,450	11	50		2,841,600	0.2	2	1,960	3.920	2,156	1,764
	Mathis	151	15	31,400	208	95		8,064,000	0.2	5	257	1,285	707	578
	Tallulah Falls	186	35	20,000	107	92		16,920,000	0.2	7	846	5,922	3,257	2,665
	Tugaloo	464	278	11,500	25	71		12,285,000	0.3	60	1,068	64,080	35,244	28,836
	Yonah	470	6	3,340	7	40		8,887,500	0.3	10	2,661	26,610	14,635	11,975
	Sub-Total											103,336	56,834	46,501
Piedmont Plateau	Clark Hill	6,144	5,674	2,900,000	472	98	49,145,500	49,145,500	0.6	3,336	17	56,712	7,014	39,698
	Issaqueena	14	14	1,837	131	93	124,439	211,546	1.33	18	115	1,965	587	1,368
	Secession	196	196	25,650	131	93	668,406	1,136,209	1.00	182	44	8,008	2,402	5,606
	Sub-Total											66,675	20,003	46,672
	Grand Total											170,010	76,837	93,173

1/ Net Drainage Area below other Dams.

2/ Estimated total present (1948) Replacement Cost.

Table D-16

BENEFITS FROM REDUCED COST OF WATER TREATMENT
SAVANNAH RIVER WATERSHED

Physical Land Unit	Name of Town	Amount Treated 1947	Cost of Treat-ment	Annual Cost		Annual Benefit
				Without Program	With Program	
		MG	$ per MG	$	$	$
Mountain-Foothills	Cornelia, Ga.	100	12	1,200	1,020	180
	Pickens, S. C.	85	100*	8,500	7,225	1,275
	Toccoa, Ga.	400	38*	15,200	12,920	2,280
	Walhalla, S. C.	200	30	6,000	5,100	900
	Westminster, S. C.	120	82*	9,840	8,364	1,476
	Sub-Total	905		40,740	34,629	6,111
Piedmont Plateau	Abbeville, S. C.	365	39	14,235	12,100	2,135
	Anderson, S. C.	1,128	26*	29,328	24,929	4,399
	Central, S. C.	80	106	8,480	7,208	1,272
	Clemson, S. C.	135	90	12,150	10,328	1,822
	Crawford, Ga.	20	150*	3,000	2,550	450
	Habersham Mill, Ga.	100	92*	9,200	7,820	1,380
	Hartwell, Ga.	150	64*	9,600	8,160	1,440
	La France, S. C.	30	60*	1,800	1,530	270
	Liberty, S. C.	42	27	1,134	964	170
	McCormick, S. C.	75	109	8,175	6,949	1,226
	Seneca, S. C.	130	80	10,400	8,840	1,560
	Washington, Ga.	91	98*	8,918	7,580	1,338
	Sub-Total	2,346		116,420	98,958	17,462
	Grand Total	3,251		157,160	133,587	23,573

* Estimated.

Table D-17

AVERAGE ANNUAL DAMAGES AND BENEFITS BY SOURCES
SAVANNAH RIVER WATERSHED

Physical Land Units	Agriculture	Roads and Railroads	Land Damage	Reservoir Silting	Water Supply Silting	Total	Reduction in Damages
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Percent
PRESENT DAMAGES							
Mountain-Foothills	210,800	62,300	3,600	103,300	40,700	420,700	
Piedmont Plateau	383,300	350,000	250,400	66,700	116,400	1,166,800	
Coastal Plain	--	68,500	--	--	--	68,500	
Total	594,100	480,800	254,000	170,000	157,100	1,656,000	
BENEFITS							
Mountain-Foothills	115,900	12,400	2,200	46,500	6,100	183,100	43.5
Piedmont Plateau	216,700	70,000	177,300	46,700	17,500	537,200	46.0
Total	332,600	82,400	179,500	93,200	23,600	720,300	43.5

Table D-18

CALENDAR YEAR AVERAGE PRICES RECEIVED
BY SAVANNAH RIVER WATERSHED FARMERS
FOR 1947, ALL AREAS

Commodity	Unit	Price
		Dollars
Cotton: Lint	Lb.	0.324
Seed	Ton	80.90
Corn	Bu.	2.06
Small Grain: Wheat	Bu.	2.42
Oats	Bu.	1.11
Rye	Bu.	2.63
Hay: All (Loose)	Ton	20.79
All	Ton	22.00
Alfalfa (Loose)	Ton	34.00
Clover and Timothy (Loose)	Ton	29.00
Lespedeza (Loose)	Ton	27.90
Soybeans and Cowpeas	Ton	29.00
Peanut (Loose)	Ton	15.00
Grain (Loose)	Ton	20.60
Prairie (Loose)	Ton	17.40
Seed: Lespedeza, all annual	Lb.	0.14
Soybeans	Bu.	4.26
Cowpeas	Bu.	5.64
Peanuts	Lb.	0.106
Irish Potatoes	Bu.	1.84
Sweet Potatoes	Bu.	2.15
Pecans, all	Lb.	0.279
Apples	Bu.	3.51
Peaches	Bu.	2.00
Lima Beans	Bu.	2.30
Snap Beans, all	Bu.	1.75
Green Peas	Bu.	1.60
Tomatoes	Bu.	3.00
Watermelons	Melon	0.22

Source: State Statistician Offices of South Carolina and Georgia and the South Carolina Agricultural Experiment Station at Clemson.

Item	Unit	Cost
		Dollars
Man Labor		
Tractor and Truck Operator	Acre	4.50
Other Labor		
Cotton Picking		
Mule Labor		
	Ton	40.00
	Ton	42.50
	Ton	38.50
Tractor Cost (Excluding driver	Ton	50.00
	Ton	25.00
	Ton	50.00
	Ton	50.00
Tractor Truck (Excluding drive	Ton	5.00
	Ton	18.00
Airplanes Dusting Cotton		
	Bu.	2.50
	Bu.	4.00
	Lb.	.20
Insecticides	Bu.	6.40
Calcium Arsenate	Bu.	4.75
Lead Arsenate	Lb.	.205
DDT and BHC Mixtures	Lb.	.16
	Lb.	.09
	Lb.	.137
Ginning, Bagging and Ties	Bu.	3.30
	Lb.	.14
	Lb.	.25
	Lb.	.081
Hauling Cotton (Farm to market)	Lb.	.30
	Lb.	.225
	Lb.	.058
	Lb.	.26
Tractor, Operator, Combine and	Lb.	.11
Materials	Lb.	.55
	Bu.	2.55
	1000	12.00
	Acre	10.00
Baling Hay		
Estimated		
Custom		

Sources: South Carolina Agriculnd Georgia; and
local agricultural wor

Table D-19

APPROXIMATE AVERAGE PRICES PAID BY SAVANNAH RIVER WATERSHED FARMERS
1947, ALL AREAS

Item	Unit	Cost
		Dollars
Man Labor		
Tractor and Truck Operators	Hr.	.50
Other Labor	Hr.	.30
Cotton Picking	CWT	2.25
Mule Labor	Hr.	.30
Tractor Cost (Excluding driver)	Hr.	.65
Tractor Truck (Excluding driver)	Hr.	.65
Airplanes Dusting Cotton	Acre	1.50
Insecticides		
Calcium Arsenate	Lb.	.15
Lead Arsenate	Lb.	.24
DDT and BHC Mixtures	Lb.	.28
Ginning, Bagging and Ties	500# Bale	6.00
Hauling Cotton (Farm to market)	500# Bale	1.00
Tractor, Operator, Combine and Materials	Acre	5.00
Baling Hay		
Estimated	Acre	5.50
Custom	65# Bale	.20

Item	Unit	Cost
		Dollars
Land and Building Charge (All conditions)	Acre	4.50
Fertilizers		
4-10-6 (Most common)	Ton	40.00
5-10-5	Ton	42.50
3-9-6	Ton	38.50
Nitrate of Soda (18%)	Ton	50.00
Phosphate (20%)	Ton	25.00
Potash (Muriate)	Ton	50.00
Ammonium Sulfate	Ton	50.00
Agr. Limestone (delivered)	Ton	5.00
Land Plaster (delivered)	Ton	18.00
Seeds		
Cotton (treated)	Bu.	2.50
Corn	Bu.	4.00
Peanuts	Lb.	.20
Cowpeas	Bu.	6.40
Soybeans	Bu.	4.75
Sericea Lespedeza	Lb.	.205
Kobe Lespedeza	Lb.	.16
Korean Lespedeza	Lb.	.09
Average Annual Lespedeza	Lb.	.137
Wheat	Bu.	3.30
Timothy	Lb.	.14
Red Top (Herds)	Lb.	.25
Austrian Peas	Lb.	.081
Crimson Clover	Lb.	.30
Hairy Vetch	Lb.	.225
Blue Lupine	Lb.	.058
Orchard Grass	Lb.	.26
Italian Rye Grass	Lb.	.11
Alfalfa	Lb.	.55
Irish Potatoes	Bu.	2.55
Kudzu Plants	1000	12.00
Pasture Mixtures	Acre	10.00

Sources: South Carolina Agricultural Experiment Station at Clemson; State Statisticians Offices of South Carolina and Georgia; and local agricultural workers.

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Crop	Unit	Pe
Corn	Bu.	
Oats	Bu.	
Wheat	Bu.	
Rye	Bu.	
Cotton, Lint	Lbs.	
Peanuts, Nuts	Lbs.	
Perennial Hay	Ton	
Annual Hay	Ton	
Lespedeza Seed	Lbs.	
Truck, Vegetables, and Small Fruits	Dols.	
Fruits and Nuts	Dols.	
Pasture	A.U. Mos.	

Note: Future increases are from ;t
fertilization of clean til

The increases are from inf.l
farm experiences. Instanc

Table D-20

EFFECTS OF FARM LAND TREATMENT MEASURES ON THE YIELDS OF MAJOR CROPS PER ACRE
SAVANNAH RIVER WATERSHED

Crop	Unit	Mountain-Foothills						Piedmont Plateau		
		Mountains			Foothills					
		Present	Future	Percent Increase	Present	Future	Percent Increase	Present	Future	Percent Increase
Corn	Bu.	28	40	43	18	30	67	16	28	75
Oats	Bu.	--	--	--	26	42	62	28	45	61
Wheat	Bu.	--	--	--	14	22	57	16	24	50
Rye	Bu.	12	16	33	--	--	--	--	--	--
Cotton, Lint	Lbs.	--	--	--	350	500	43	330	460	39
Peanuts, Nuts	Lbs.	--	--	--	--	--	--	--	--	--
Perennial Hay	Ton	1.0	1.6	60	1.0	1.7	70	1.0	1.6	60
Annual Hay	Ton	1.4	2.0	43	1.0	1.5	50	.8	1.5	88
Lespedeza Seed	Lbs.	--	--	--	158	250	58	175	250	43
Truck, Vegetables, and Small Fruits	Dols.	121	155	28	97	129	33	99	135	36
Fruits and Nuts	Dols.	228	316	39	148	212	43	113	182	61
Pasture	A.U. Mos.	2.9	5.0	72	2.1	5.0	138	2.3	5.0	117

Note: Future increases are from soil conserving practices only -- excludes from consideration such practices as direct fertilization of clean tilled row crops, use of hybrid seeds, etc.

The increases are from information supplied by agricultural workers within the watershed and are based on actual farm experiences. Instances of high percentage increases are associated with low present yields.

Table D-21

COST OF PRODUCING CROPS PER ACRE, PRESENT AND FUTURE
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Enterprise	Mountain-Foothills				Piedmont Plateau	
	Mountains		Foothills			
	Present	Future	Present	Future	Present	Future
	$	$	$	$	$	$
Corn	37.50	44.70	32.20	38.70	30.80	37.30
Oats	--	--	25.70	31.00	26.30	31.30
Wheat	--	--	27.00	31.00	28.00	31.60
Rye	27.00	29.60	--	--	--	--
Cotton (inc. seed)	--	--	71.40	90.40	67.40	84.40
Peanuts (inc. hay)	--	--	--	--	--	--
Alfalfa Hay	17.10	21.70	17.10	21.70	19.00	25.00
Cowpea Hay	31.20	33.90	25.90	29.20	25.10	27.80
Lespedeza Hay	17.90	23.20	15.10	19.10	14.50	19.20
Small Grain Hay	--	--	26.20	29.50	25.20	29.20
Clover and Timothy Hay	24.40	28.40	--	--	--	--
Meadow Hay	--	--	--	--	13.70	--
Kudzu Hay	13.70	13.70	13.70	13.70	13.70	13.70
Sericea Hay	13.70	18.80	13.70	18.80	13.70	18.80
Lespedeza Seed	--	--	12.10	16.80	13.10	16.80
Irish Potatoes	133.70	145.00	122.40	130.90	116.70	130.90
Sweet Potatoes	121.60	149.60	168.30	201.90	168.30	201.90
Watermelons	37.50	47.50	37.00	47.50	37.00	47.50
Snap Beans	96.80	121.00	87.50	108.90	78.00	96.80
Tomatoes	--	--	99.70	111.20	99.70	111.20
Green Peas	--	--	121.00	121.00	--	--
Apples	80.00	92.00	69.00	81.00	65.00	77.00
Peaches	--	--	75.00	87.00	60.00	72.00
Pecans	--	--	--	--	25.00	37.00
Pasture	4.40	6.70	3.20	5.50	3.50	5.80

Table D-22

ESTIMATED CO RE

Sources of Cost	au
Corn	0
Oats	0
Wheat	0
Rye	
Cotton (inc. seed)	0
Peanuts (inc. hay)	
Alfalfa Hay	0
Cowpea Hay	0
Lespedeza Hay	0
Small Grain Hay	0
Clover and Timothy Hay	
Meadow Hay	
Kudzu Hay	0
Sericea Hay	0
Lespedeza Seed	0
Irish Potatoes	0
Sweet Potatoes	0
Watermelons	0
Snap Beans	0
Tomatoes	0
Green Peas	
Apples	0
Peaches	0
Pecans	0
Pasture	0
Total Cost	0

Table D-22

ESTIMATED COST OF PRODUCING CROPS BY PHYSICAL LAND UNITS AND THEIR SUBDIVISIONS, PRESENT AND FUTURE
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Sources of Cost	Mountain-Foothills				Piedmont Plateau	
	Mountains		Foothills			
	Present	Future	Present	Future	Present	Future
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Corn	812,180	561,790	764,720	552,560	5,957,550	5,558,450
Oats	--	--	126,190	151,340	3,510,520	4,487,170
Wheat	--	--	145,830	163,990	2,787,820	3,376,140
Rye	47,440	226,530	--	--	--	--
Cotton (inc. seed)	--	--	1,104,060	860,430	17,006,570	16,407,360
Peanuts (inc. hay)	--	--	--	--	--	--
Alfalfa Hay	460	590	310	390	8,800	11,580
Cowpea Hay	84,860	83,020	62,760	194,760	458,480	1,085,870
Lespedeza Hay	46,590	53,270	41,870	146,520	1,112,640	3,139,970
Small Grain Hay	--	--	171,510	191,870	1,336,730	1,603,660
Clover and Timothy Hay	80,450	82,590	--	--	--	--
Meadow Hay	--	--	--	--	68,490	--
Kudzu Hay	4,930	40,000	16,630	83,190	261,340	1,130,770
Sericea Hay	4,520	95,450	14,950	328,040	288,540	2,417,530
Lespedeza Seed	--	--	10,370	39,230	630,060	1,722,340
Irish Potatoes	183,700	199,230	35,500	37,960	213,210	239,150
Sweet Potatoes	78,800	96,940	128,410	154,050	946,010	1,134,880
Watermelons	72,150	91,390	107,120	137,510	723,940	929,380
Snap Beans	361,550	451,940	57,580	71,660	455,600	565,410
Tomatoes	--	--	41,570	46,370	378,460	422,120
Green Peas	--	--	50,460	50,460	--	--
Apples	110,640	127,240	37,600	44,140	115,500	136,830
Peaches	--	--	9,600	11,140	91,440	109,730
Pecans	--	--	--	--	8,180	12,100
Pasture	82,610	167,120	77,810	219,060	994,480	2,469,680
Total Cost	1,970,880	2,277,100	3,004,850	3,484,670	37,354,360	46,960,120

Measure	Annual Maintenance 2/ Federal	Non-Federal Public	Non-Federal Private
	Dollars	Dollars	Dollars
LAND TREATMENT			
Open Land			
1. Sub-watershed Waterways	--	--	37,400
2. Gully Stabilization and Sediment	--	--	129,200
3. Erosion Control along Railroads a Roadways	--	414,300	20,900
4. Field Diversions	--	--	27,600
5. Terraces	--	--	217,100
6. Perennial Vegetation	--	--	109,200
7. Pasture Improvement	--	--	115,000
8. Field Border Plantings	--	--	46,500
9. Farm Waterways	--	--	143,000
Sub-total	--	414,300	845,900
Woodland			
10. Adequate Fire Protection	71,400	33,000	--
11. Tree Planting for Cover Restoratio			
(a) Private lands	--	--	--
(b) Lands to be acquired	--	--	--
12. Cover Improvement, Privately Owned Woodlands	38,900	38,900	--
13. Public Acquisition of Watershed La	--	--	--
14. Development and Management of Land to be acquired	48,000	--	--
Sub-total	158,300	71,900	--
TRIBUTARY CHANNEL IMPROVEMENT AND STRE BANK STABILIZATION	--	45,800	--
FACILITATING SERVICES			
15. Technical Services 4/	--	--	--
16. Educational Assistance	--	--	--
Sub-total	--	--	--
Total	158,300	532,000	845,900

1/ This table does not include amounts
2/ Maintenance includes certain woodla
3/ Federal costs of installation of in ts of direct aids.
4/ Costs for investigations, designs, 00 and costs for technical service on open land, totaling $137

Table D-23

INSTALLATION AND MAINTENANCE COSTS OF RECOMMENDED PROGRAM
BY GROUPS OF MEASURES AND ALLOCATION OF COSTS 1/
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Measure	Unit	Total Amount	Installation				Annual Maintenance 2/			
			Total Cost	Federal	Non-Federal Public	Non-Federal Private	Total	Federal	Non-Federal Public	Non-Federal Private
			Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
LAND TREATMENT										
Open Land										
1. Sub-watershed Waterways	Mile	440	822,800	658,200	--	164,600	37,400	--	--	37,400
2. Gully Stabilization and Sediment Control	Mile	3,690	1,531,200	1,225,100	--	306,100	129,200	--	--	129,200
3. Erosion Control along Railroads and Roadways	Mile	10,880	1,642,900	410,700	1,192,800	39,400	435,200	--	414,300	20,900
4. Field Diversions	Mile	1,150	121,900	30,500	--	91,400	27,600	--	--	27,600
5. Terraces	Mile	18,090	958,800	239,700	--	719,100	217,100	--	--	217,100
6. Perennial Vegetation	Acre	15,600	561,600	140,400	--	421,200	109,200	--	--	109,200
7. Pasture Improvement	Acre	11,500	310,500	77,600	--	232,900	115,000	--	--	115,000
8. Field Border Plantings	Acre	9,300	279,000	69,800	--	209,200	46,500	--	--	46,500
9. Farm Waterways	Acre	28,600	858,000	214,500	--	643,500	143,000	--	--	143,000
Sub-total			7,086,700	3,066,500 3/	1,192,800	2,827,400	1,260,200	--	414,300	845,900
Woodland										
10. Adequate Fire Protection	Acre	2,221,000	1,826,000	913,000	913,000	--	104,400	71,400	33,000	--
11. Tree Planting for Cover Restoration										
(a) Private lands	Acre	139,200	2,269,600	567,400	--	1,702,200	--	--	--	--
(b) Lands to be acquired	Acre	28,700	479,700	479,700	--	--	--	--	--	--
12. Cover Improvement, Privately Owned Woodlands	Acre	1,564,000	1,167,000	583,500	583,500	--	77,800	38,900	38,900	--
13. Public Acquisition of Watershed Lands	Acre	320,000	4,800,000	4,800,000	--	--	--	--	--	--
14. Development and Management of Lands to be acquired	Acre	320,000	776,000	776,000	--	--	48,000	48,000	--	--
Sub-total			11,318,300	8,119,600 3/	1,496,500	1,702,200	230,200 2/	158,300	71,900	--
TRIBUTARY CHANNEL IMPROVEMENT AND STREAM BANK STABILIZATION	Mile	1,720	2,291,000	1,947,300	--	343,700	45,800	--	45,800	--
FACILITATING SERVICES										
15. Technical Services 4/	--	--	1,080,000	1,080,000	--	--	--	--	--	--
16. Educational Assistance	--	--	330,000	165,000	165,000	--	--	--	--	--
Sub-total			1,410,000	1,245,000	165,000	--	--	--	--	--
Total			22,106,000	14,378,400 3/	2,854,300	4,873,300	1,536,200	158,300	532,000	845,900

1/ This table does not include amounts or costs of "going" programs.
2/ Maintenance includes certain woodland costs of an annual operational nature.
3/ Federal costs of installation of individual measures include costs of direct aids, including $192,000 administrative costs of direct aids.
4/ Costs for investigations, designs, planning and integrating measures and for inspection and supervision, totaling $943,000 and costs for technical service on open land, totaling $137,000 are included.

Table D-24

CHANNEL IMPROVEMENT AND STREAM BANK STABILIZATION
SUMMARY AND ALLOCATION OF COSTS, 1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

	Total	Federal	Non-Federal	
			Public	Private
	Dollars	Dollars	Dollars	Dollars
COST OF INSTALLATION				
Cost of Recommended Program 1/	2,635,000	2,291,300	--	343,700
AVERAGE ANNUAL COST				
Annual Equivalent of Installation	71,000	57,300	--	13,700
Annual Operation and Maintenance	45,800	--	45,800	--
Total Average Annual Cost	116,800	57,300	45,800	13,700

1/ These costs include $344,000 for investigation, design, planning and integrating measures, for inspection and supervision, and for technical services and educational assistance.

Table D-25

GROSS INCOME PER ACRE FROM CROPS AND LIVESTOCK, PRESENT AND FUTURE
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Enterprise	Mountain-Foothills				Piedmont Plateau	
	Mountains		Foothills			
	Present	Future	Present	Future	Present	Future
	$	$	$	$	$	$
Corn	57.70	82.40	37.10	61.80	33.00	57.70
Oats	--	--	28.90	46.60	31.10	50.00
Wheat	--	--	33.90	53.20	38.70	58.10
Rye	31.60	42.10	--	--	--	--
Cotton (inc. seed)	--	--	139.50	199.30	131.40	183.10
Peanuts (inc. hay)	--	--	--	--	--	--
Alfalfa Hay	34.00	68.00	34.00	68.00	44.20	85.00
Cowpea Hay	46.40	58.00	29.00	43.55	26.10	37.70
Lespedeza Hay	33.50	55.80	25.10	41.80	22.30	41.80
Small Grain Hay	--	--	20.60	30.90	18.50	30.90
Clover and Timothy Hay	41.40	59.20	--	--	--	--
Meadow Hay	--	--	--	--	17.40	--
Kudzu Hay	34.00	34.00	34.00	34.00	34.00	34.00
Sericea Hay	27.90	55.80	27.90	55.80	27.90	55.80
Lespedeza Seed	--	--	22.10	35.00	24.50	35.00
Irish Potatoes	147.20	184.00	110.40	138.00	92.00	138.00
Sweet Potatoes	139.80	172.00	193.50	232.20	193.50	232.20
Watermelons	57.20	88.00	55.00	88.00	55.00	88.00
Snap Beans	140.00	175.00	122.50	157.50	105.00	140.00
Tomatoes	--	--	180.00	225.00	180.00	225.00
Green Peas	--	--	80.00	80.00	--	--
Apples	228.20	315.90	140.40	210.60	105.30	175.50
Peaches	--	--	180.00	220.00	140.00	220.00
Pecans	--	--	--	--	25.10	41.80
Pasture 1/	8.50	14.70	6.20	14.70	6.80	14.70

1/ Pasture is evaluated as hay equivalent

ESTIMATED TOTAL GROSS FARM INCOM RESENT AND FUTURE

Source of Income	t Plateau
	Future
	Dollars
Corn	8,598,450
Oats	7,168,000
Wheat	6,207,400
Rye	--
Cotton (inc. seed)	35,594,640
Peanuts (inc. hay)	--
Alfalfa Hay	39,360
Cowpea Hay	1,472,560
Lespedeza Hay	6,835,970
Small Grain Hay	1,697,030
Clover and Timothy Hay	--
Meadow Hay	--
Kudzu Hay	2,806,290
Sericea Hay	7,175,430
Lespedeza Seed	3,588,200
Irish Potatoes	252,130
Sweet Potatoes	1,305,200
Watermelons	1,721,810
Snap Beans	817,740
Tomatoes	854,100
Green Peas	--
Apples	311,860
Peaches	335,280
Pecans	13,670
Pasture	6,259,360
Total Income	93,054,480

Table D-26

ESTIMATED TOTAL GROSS FARM INCOME FROM CROPS, PASTURE, AND LIVESTOCK BY PHYSICAL LAND UNITS AND THEIR SUBDIVISIONS, PRESENT AND FUTURE
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Source of Income	Mountain-Foothills				Piedmont Plateau	
	Mountains		Foothills			
	Present	Future	Present	Future	Present	Future
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Corn	1,249,670	1,035,600	381,090	882,380	6,383,090	8,598,450
Oats	--	--	141,900	227,500	4,151,230	7,168,000
Wheat	--	--	183,090	281,430	3,853,170	6,207,400
Rye	55,520	322,190	--	--	--	--
Cotton (inc. seed)	--	--	2,157,090	1,896,940	33,155,240	35,594,640
Peanuts (inc. hay)	--	--	--	--	--	--
Alfalfa Hay	920	1,840	610	1,220	20,460	39,360
Cowpea Hay	126,210	142,040	70,270	290,140	476,740	1,472,560
Lespedeza Hay	87,200	128,120	69,600	320,650	1,711,170	6,835,970
Small Grain Hay	--	--	134,850	200,970	981,330	1,697,030
Clover and Timothy Hay	136,500	172,150	--	--	--	--
Meadow Hay	--	--	--	--	86,980	--
Kudzu Hay	12,240	99,280	41,280	206,450	648,580	2,806,290
Sericea Hay	9,210	283,300	30,440	973,650	587,600	7,175,430
Lespedeza Seed	--	--	18,940	81,720	1,178,350	3,588,200
Irish Potatoes	202,250	252,820	32,020	40,020	168,080	252,130
Sweet Potatoes	90,590	111,460	147,640	177,170	1,087,660	1,305,200
Watermelons	110,050	169,310	159,220	254,760	1,076,130	1,721,810
Snap Beans	522,900	653,620	80,600	103,640	613,300	817,740
Tomatoes	--	--	75,060	93,820	683,280	854,100
Green Peas	--	--	33,360	33,360	--	--
Apples	315,600	436,890	76,520	114,780	187,120	311,860
Peaches	--	--	23,040	28,160	213,360	335,280
Pecans	--	--	--	--	8,210	13,670
Pasture	159,590	366,680	150,760	585,490	1,932,120	6,259,360
Total Income	3,078,450	4,175,300	4,507,380	6,794,250	59,203,200	93,054,480

Table D-27

ANNUAL BENEFITS FROM REDUCTION OF
PUBLIC ROAD AND RAILROAD MAINTENANCE
SAVANNAH RIVER WATERSHED

Area	Annual Cost of Road Maintenance Due to Erosion		Benefits
	Without Program	With Program	
	Dollars	Dollars	Dollars
Mountain-Foothills	61,500	20,300	41,200
Piedmont Plateau	345,000	113,900	231,100
Total	406,500	134,200	272,300

Table D-28

ESTIMATED ANNUAL WOODLAND GROSS RETURNS AND PRODUCTION COSTS 1/
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Program	Woodland Area	Annual Growth		Annual Production Costs		Gross Annual Returns	
		Per Acre	Watershed	Per Cu.Ft. 2/	Watershed	Per Cu.Ft. 3/	Watershed
	Acres	Cu. Ft.	Cu. Ft.	Dollars	Dollars	Dollars	Dollars
Present							
Sawtimber	--	--	65,904,489	0.14000	9,226,628	0.27500	18,123,734
Pulpwood	--	--	32,952,245	0.08333	2,745,911	0.12222	4,027,423
Total Present	2,601,493	38	98,856,734	--	11,972,539	--	22,151,157
Future With Going Plus Recommended Program							
Sawtimber	--	--	171,089,110	0.14000	23,952,475	0.27500	47,049,505
Pulpwood	--	--	85,544,555	0.08333	7,128,428	0.12222	10,455,256
Total future	2,701,407	95	256,633,665	--	31,080,903	--	57,504,761
Increase Due to Combined Programs	--	57	--	--	19,108,364	--	35,353,604

1/ As estimated for approximately the 30th year after installation of program when the growing stock reaches full potential.

2/ Based on an estimated production cost of $28.00 per thousand board feet and $7.50 per cord of pulpwood.

3/ Based on an estimated green lumber value of $55.00 per thousand board feet and a value of $11.00 per cord of pulpwood delivered to railroad siding.

Table D-29

COST OF WOODLAND MEASURES
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Measure	Quantity	Installation Costs				Operation and Maintenance Costs During 15-Yr. Installation Period				Total Costs for Installation Period			
		Federal	Non-Federal		Total	Federal	Non-Federal		Total	Federal	Non-Federal		Total
			Public	Private			Public	Private			Public	Private	
	Acres	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Adequate Fire Protection	2,221,000 1/	125,600	125,600	--	251,200	787,400	787,400	--	1,574,800	913,000	913,000	--	1,826,000
Tree Planting for Cover Restoration -													
Private Lands	139,200	567,400	--	1,702,200	2,269,600	--	--	--	--	567,400	--	1,702,200	2,269,600
Lands to be Acquired	28,700	479,700	--	--	479,700	--	--	--	--	479,700	--	--	479,700
Cover Improvement, Privately Owned Woodlands	1,564,000	583,500	583,500	--	1,167,000	--	--	--	--	583,500	583,500	--	1,167,000
Public Acquisition of Watershed Lands	320,000	4,800,000	--	--	4,800,000	--	--	--	--	4,800,000	--	--	4,800,000
Development and Management of Lands to be Acquired	320,000	416,000	--	--	416,000	360,000	--	--	360,000	776,000	--	--	776,000
Total		6,972,200	709,100	1,702,200	9,383,500	1,147,400	787,400	--	1,934,800	8,119,600	1,496,500	1,702,200	11,318,300

1/ Total future forest area exclusive of national forests and North Carolina.

Table D-30

SUMMARY AND DISTRIBUTION OF COSTS OF THE RECOMMENDED PROGRAM 1/
1947 AVERAGE PRICES
SAVANNAH RIVER WATERSHED

Groups of Measures	Total	Federal	Non-Federal Public	Non-Federal Private
	Dollars	Dollars	Dollars	Dollars
	TOTAL INSTALLATION COSTS			
LAND TREATMENT				
Open Land	7,086,700	3,066,500	1,192,800	2,827,400
Woodland	11,318,300	8,119,600	1,496,500	1,702,200
Facilitating Services	1,066,000	901,000	165,000	--
Sub-total	19,471,000	12,087,100	2,854,300	4,529,600
CHANNEL IMPROVEMENT AND STREAM BANK STABILIZATION				
Installation	2,291,000	1,947,300	--	343,700
Facilitating Services	344,000	344,000	--	--
Sub-total	2,635,000	2,291,300	--	343,700
Total Installation Costs	22,106,000	14,378,400	2,854,300	4,873,300
	AVERAGE ANNUAL COSTS			
LAND TREATMENT				
Installation 2/	554,800	302,200	71,400	181,200
Maintenance 3/	1,490,400	158,300	486,200	845,900
Sub-total	2,045,200	460,500	557,600	1,027,100
CHANNEL IMPROVEMENT AND STREAM BANK STABILIZATION				
Installation	71,000	57,300	--	13,700
Maintenance	45,800	--	45,800	--
Sub-total	116,800	57,300	45,800	13,700
Total Average Annual Direct Costs	2,162,000	517,800	603,400	1,040,800

1/ These costs are based on Table D-23. Facilitating services are prorated to the openland and channel improvement groups of measures in computing average annual costs.

2/ Installation costs were converted to an average annual equivalent by multiplying total Federal and non-Federal Public costs by 2 1/2 percent and private costs by 4 percent.

3/ Maintenance includes certain woodland costs of an operational nature.

Table D-31

COMPARISON OF UNADJUSTED (1947 PRICES AND COSTS) AND ADJUSTED AVERAGE ANNUAL BENEFITS AND COSTS OF THE RECOMMENDED PROGRAM SAVANNAH RIVER WATERSHED

	Unadjusted	Adjusted 1/
	Dollars	Dollars
BENEFITS		
Channel Improvement	393,600	228,700
Other Flood Control	107,200	62,300
Associated	24,579,600	12,560,200
Total	25,080,400	12,851,200
COSTS		
Federal	517,800	407,500
Non-Federal		
Public	603,400	474,900
Private	12,524,000	8,592,800
Total	13,645,200	9,475,200

1/ Adjusted by use of future indexes furnished by the Bureau of Agricultural Economics.

APPENDIX E

PLAN OF IMPROVEMENT

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PLAN OF IMPROVEMENT

INTRODUCTION

The recommended watershed treatment program for the Savannah River drainage basin in North Carolina, South Carolina, and Georgia has been developed with the primary objective of alleviating flood water and sediment damages.

The total area of the watershed is approximately 6,770,560 acres, of which 114,560 acres are in North Carolina, 2,899,200 acres are in South Carolina, and 3,756,800 acres are in Georgia.

Of the total area, approximately 61 percent, or 4,130,871 acres, is land in farms, and 39 percent, or 2,639,689 acres, is land not in farms. All of the non-farm lands are included in non-farm woodland with the exception of 344,962 acres of miscellaneous lands which are in urban areas, roads, streams, etc.

Special consideration has been given to those measures which will result in maximum flood control and water conservation benefits. The inter-relation between such measures and sound land use necessitates the development of a complete system of soil and water conservation as an integral part of the recommended program if maximum benefits are to be realized.

For evaluation purposes, all measures included in the recommended program have been grouped as follows:

Group 1 - All land treatment measures and other measures closely associated with land treatment.

Group 2 - Measures not included in Group 1, but supplemental to land treatment measures.

Measures included in Group 1 have further been subdivided into two groups:

A. Land treatment measures that will be installed under the "going" programs during installation period.

B. All remaining land treatment measures and additional measures essential to the application and proper functioning of the land treatment measures.

Procedure Used in Developing Recommended Program

Present land use and physical land conditions, indicated by capability classes, were used as basic data in developing the present condition of the watershed (Table A-1, Appendix A). Recommendations for land treatment were developed to show the needs for treatment within the watershed. These recommendations are based on the experience of Soil

Conservation Service and other local agricultural workers and that of local soil conservation district supervisors. Accomplishments on farms through June 1949 were considered in estimating needs in kinds and amounts of measures.

More than 98 percent of the entire watershed area is in active soil conservation districts. Conferences were held with supervisors of these districts and technicians and representatives of other agencies. At each of these conferences data was presented indicating present land use as revealed by the 1945 census and other acceptable sources of information. Tabulations were also shown indicating the acreage of land capability classes in each land use, as obtained from sample soil conservation surveys. Using these data as a basis, also taking into consideration local agricultural trends including availability of farm labor and present economic conditions, the supervisors recommended land use changes, as well as the conservation practices needed, in order to apply a complete watershed program in their respective districts.

The present and proposed uses, together with net changes by physical land units are shown in Table E-1.

These proposed land use changes are based on recommendations of the governing bodies of local soil conservation districts but adjusted to and summarized by major physical land units. These physical land units are shown in Figure E-1. The significant changes are: Decreased rotated cropland, 161,080 acres; increased pasture, 163,353 acres; increased woodland, 99,914 acres; increased perennial vegetation, 144,110 acres; increased areas for wildlife, 15,278 acres; and the application of beneficial measures to 311,982 acres of idle land.

An estimate of watershed needs by measures, the reported accomplishment of "going" programs, and the recommended program are shown in Table E-2.

In order to determine the annual rate of accomplishment of "going" programs for the needed measures, records and reports of the various agencies concerned were analyzed and consolidated.

The fiscal year 1949 was used as a basis for estimating the annual rate of accomplishments on farms cooperating with soil conservation districts. Calendar years 1947 and 1948 for Georgia, 1947 for North Carolina, and 1949 for South Carolina were considered most representative as to accomplishment rates for the Production and Marketing Administration.

GROUP 1 MEASURES - LAND TREATMENT

Open Land

The proposed measures and practices for both flood control and conservation of watershed lands will conserve soil and water, improve infiltration, reduce runoff, and increase soil fertility. The proposed measures and practices for open land are: (1) Subwatershed

waterways, (2) Gully stabilization and sediment control, (3) Erosion control along railroads and roadways, (4) Terraces and field diversions, (5) Perennial vegetation, (6) Pasture improvement, (7) Field borders, (8) Farm waterways, and (9) Other farm and water conservation practices and measures, including technical and educational assistance.

It is recommended that 248,090 acres of crop, idle, and pasture lands in capability Class VII (Table A-1, Appendix A) be planted to perennials and/or trees. These areas are the major sources of silt and accelerated runoff which increase flood hazards and damages.

The larger portion of such areas is recommended for perennials since they afford immediate protection to the land and will give a larger permanent return of hay or pasture as well as increased food and cover for wildlife.

The recommended program imposes no major change in the production of cash crops. However, sound land use requirements, make some reduction necessary in the acreage of clean tilled row crops. The principal cash crop will continue to be cotton, except in the mountains where fruits and vegetables will continue to predominate and where no cotton is grown at present. The proposed increase in area of pasture and close growing crops and the decrease in area of row crops is in keeping with current trends toward increased production of livestock which necessitates substantial increased pasture and hay crops. The increased pasture and hay crop acreage also means an increased safety margin in using the land within its capabilities. Row crop acres, in approved crop rotations, will be sufficient for economic needs on the better classes of land requiring less complex conservation measures.

These necessary conservation measures and land use changes serve a dual purpose in the recommended program: First, they reduce runoff and sedimentation from critical silt-source areas, which are distinct public benefits; secondly, they conserve soil and water and improve land with accompanying increased revenue to landowners, thereby resulting in private benefits.

Subwatershed Waterways

The waterways on individual farms discharge storm runoff into secondary channels which in turn flow through other farms and finally discharge into the tributary streams. This concentrated volume of uncontrolled runoff produces excessive scour in the secondary channels which will seriously damage the bottom lands by deposition of harmful sediment. It is therefore important that adequate water disposal systems be planned, established, and maintained as group enterprises.

When the water disposal system of two or more individual farms discharges into a common outlet, it is necessary to provide adequate channel capacity, as well as apply measures which will prevent both excessive scour and the formation of gullies. In some cases, this difficulty can be alleviated only by providing channel outlets entirely across the flood plains to the tributary stream outlets. The disposal of water from hill lands without flood damage to fertile bottom lands is dependent on adequate channel outlets.

In some cases, the topography will permit the establishment of perennial vegetative outlets for group water disposal systems. Where secondary channels exist, brushing operations and some grading may be necessary to prevent meandering and the impediment of stream flows. In some instances, structures may be necessary where large quantities of runoff or eroding soils occur. In the design of water disposal systems for subwatersheds it is sometimes necessary to provide for a small amount of flood water storage in some of the structures. These small detention type flood water storage measures are recommended for use in water disposal systems as stabilizing measures in headwater areas. They will consist of small earth-fill dams with an outlet to release water at a fixed and safe rate and with auxiliary spillways adapted to site conditions. Since these installations will be small, their effectiveness will be most beneficial in reducing the installation cost of control measures immediately below the site. They will also produce additional benefits by furnishing some protection to flood plain lands and improvements.

Approximately 440 miles of subwatershed waterways will require treatment.

Gully Stabilization and Sediment Control

Gullies are one of the principal sources of sediment. The effectiveness of the recommended program in reducing sedimentation damages depends to a large extent on the control of gully erosion.

It is estimated that there are approximately 3,690 miles of major gullies which will require treatment. This estimated amount of gully treatment does not include occasional gullies which will be stabilized under normal conservation farm operations.

Gully treatment will consist of vegetative stabilization and supporting structural measures as required. Mulching, small check dams, and other structural measures will facilitate the establishment of kudzu, sericea, grass, shrubs, and other perennials. Temporary dikes and diversion ditches will be constructed to intercept and divert runoff from overlying areas into stabilized waterways where practicable. Fence construction and vegetative barriers will be used where necessary for protection of such areas from grazing.

Sediment can be controlled by measures that spread and reduce the velocity of flood flows. Temporary earth dams may be used at the mouth of large gullies. Vegetative barriers are most effective. Plants that are close growing, deep rooted, with low, dense foliage which is not readily eaten by stock are recommended. Usually, low value bottom land or lands already damaged by deposition will be used for these desilting areas.

Road Bank Stabilization

A reconnaissance survey was made to observe the present conditions of the road systems within the watershed and to estimate the types and amounts of erosion control measures necessary to stabilize the cut and fill slopes.

The road system was classified into three types of roads: Principal Highways (hard surface); Improved Roads (soil type and surface treated); and Unimproved Roads.

The principal highways will require the greatest amounts of stabilization measures, This is a reflection of large areas of cuts and fills per mile of this class of highway.

The improved roads will require smaller amounts of stabilization measures than the principal highways but larger amounts than the unimproved roads.

Existing gullies adjacent to roads will also require vegetative stabilization measures.

The measures on roads will generally consist of seedbed preparation, including fertilization, seeding or planting of vegetative cover, and mulching the steep slopes. Suitable vegetation will be planted along outfall ditches and other silt-source areas. Structures will be used where large quantities of concentrated runoff or erodible soils make vegetative measures inadequate.

Vine type perennial vegetation is recommended on the deeper and steeper cut slopes and ditch sections. Perennials and reseeding annual types of vegetation are recommended for treating the flatter slopes where conditions are more favorable for their growth.

The stabilization of road cut and fill slopes and drainage ways will effect a major reduction in the volume of sand and silt transported from these areas. This will greatly reduce the volume of such material deposited in road ditches and drainage ways, or on lower lying agricultural land and inevitably in the streams. The cost of maintenance of road rights-of-way and damages to adjacent farm lands will be reduced.

It is estimated that 10,570 miles of road banks will need treatment consisting of stabilizing structures and vegetative planting.

Erosion Control Along Railroads

Erosion control along railroad rights-of-way differs from that of highways in that the fill-slopes along railways are usually protected with adequate vegetation in order to maintain the roadbed. However, the steep unprotected excavated slopes contribute large quantities of silt. It is on these areas that the major portion of vegetative planting is necessary. It is estimated that 310 miles of railroad cut slopes will need vegetative treatment.

Terraces and Field Diversions

Terraces will be installed to manage the runoff from sloping lands, principally those in cultivation, and to reduce soil erosion and sediment damage. Field diversions will generally be installed on slopes, and at toe-slopes, too steep for terraces but where orderly discharge of surface runoff is necessary for the protection of lands lying immediately below them. Approximately 10,090 miles of terraces and 1,150 miles of diversions are recommended.

Perennial Vegetation

Combinations of perennial grasses and legumes in the proposed program serve a dual purpose: First, they afford immediate protection to the land from serious erosion and runoff problems; secondly, they provide hay and grazing for livestock. Such conservation practices as land preparation, fertilizing, liming, seeding, and others will be necessary on about 15,600 acres to attain desirable hydrologic conditions on these lands.

Pasture Improvement

About 11,500 acres of old pasture lands will need additional treatment such as fertilizing, liming, seeding, and other renovating measures in order to improve the hydrologic condition to a desirable level.

These renovating measures serve a dual purpose in the recommended program: First, they provide heavy duty vegetation for the poorer classes of land which would otherwise require more complex and expensive measures in order to materially reduce runoff and sediment damages; second, with proper maintenance and grazing practices they provide additional pasture for an expected increase in livestock production.

Field Border Plantings

Small irregular and inaccessible areas, as well as narrow strips of land along field borders, often left idle are sources of serious erosion and present annoying runoff problems. It is proposed that this condition be corrected by planting approximately 9,300 acres

of such areas to adapted plants that will control erosion and produce food and cover for wildlife. Fences will be constructed or vegetative fences planted where necessary to furnish protection from grazing.

Farm Waterways

Farm waterways will consist of both natural and artificial water courses to provide safe disposal of excess water from farms. Farm waterways will, in most cases, be vegetated and will include such measures as broad meadow strips, constructed channels, and vegetated terrace outlets. The natural topography of adjacent farms will determine the planning and installation of water disposal systems in order that the water disposal systems of all farms involved may operate as a unit. Waterways will usually extend from the top of terraced slopes to suitable outlets. In some cases it will be necessary for waterways to cross flood plain land to reach suitable outlets. The proper disposal of excess water from farm land into adequate outlets will reduce sediment damage to lower lying lands and minimize consequent reduction in yields to these lands. Supporting structures will be installed to implement vegetative control where necessary. It is estimated that 28,600 acres of farm waterways will be needed.

Woodland

Forest Fire Protection

Adequate fire protection will be provided for 2,221,000 acres of woodland, including some 320,000 acres of watershed land recommended for Federal acquisition, with the aim of limiting the annual burn to 0.5 percent or less of the protected area.

Only on national forests, and on private woodlands in the North Carolina portion of the watershed, will the protection afforded by going programs be adequate for flood control needs. Fire records indicate that the 480,000 acres in this category sustains an average annual burn of less than 0.5 percent. Since this calibre of protection is adequate for flood control needs, no intensification of the existing fire protection system for these areas is recommended.

At present, some 837,000 acres of woodland, all in Georgia, are unprotected. It is estimated that this acreage will be incorporated with existing protection units under the going program during the 15-year period for installing flood control measures.

Fire records for the past decade for protected woodland acreage in the two States--Georgia and South Carolina--show need for considerable intensification of protection facilities. At current appropriation levels, state forestry agencies can only moderately strengthen the present protective system for private forest lands.

Recommendations, therefore, provide for strengthening protection on 2,221,000 acres that will receive some protection under the going program. An intensive type of protection which includes trained personnel, a complete fire detection system, quarters for lookouts, telephone and radio communications, and fire fighting equipment such as trucks, tractors, fire plows, and hand tools, is proposed.

The recommended program contemplates that effective use will be made of equipment, structures, and personnel available under the cooperative Federal-State protection systems. Estimates provide only for the additional equipment, improvements, and personnel that are needed in strengthening organizations. The total capital investment cost for installing an adequate system is estimated at $0.312 per forest acre, of which the cost of proposed additional facilities averages 11.3 cents per acre.

While physical improvements and equipment are necessary elements in providing adequate fire protection, the success of protection efforts hinges largely on building up public attitudes favorable to fire prevention and control. A fire prevention campaign, vigorously conducted, will be an essential part of the program.

It is recommended that the Federal Government bear half the cost of installation and of annual operation and maintenance of improved fire control on private land, the remaining costs to be borne by the States of Georgia and South Carolina in proportion to the cost of the program for the respective States. The Federal Government will bear the entire cost of fire protection of lands recommended for public ownership after such lands have been acquired.

Cover Improvement, Privately-Owned Woodlands

This measure provides for improving protective ground cover on 1,564,000 1/ acres of private woodlands by increasing the density and vigor of forest stands. The work is to be accomplished through an expanded program of technical services, provided at public expense to woodland owners and operators.

The large percentage of forest land with inadequate cover reflects the lack of purposeful management of most of the private woodland. Though capable of producing timber at growth rates comparable to the best in the nation, the forest lands have been so wastefully exploited that they are now producing at less than one-third of potential. Improvement of watershed cover and of timber resources alike requires protection from fires and other destructive agencies, timber cultural practices, judicious cutting, and provision for prompt restocking after harvesting.

Substantial progress is being made in timber management, particularly by industrial and other owners of large acreages. Many of these

1/ Excludes some 388,000 acres in larger holdings which are expected to be adequately managed without additional public assistance.

employ experienced foresters as woodland managers, or make use of the technical services of consultants. It is estimated that about one-fifth of the private woodland will be managed at a level compatible with flood control objectives without need for special public assistance.

The remaining four-fifths of the private woodland is in small holdings, mostly so small or so depleted that they provide very low returns to their owners. Lacking forestry skills and with their major income from other sources, most small forest owners are not aware of the opportunities for good forestry and have made few attempts as yet to manage their lands for sustained production. Since management of small tracts is seldom attractive to consulting foresters, very few owners will obtain adequate technical assistance through regular commercial channels. A limited amount of technical aid is now provided in parts of the watershed under a cooperative Federal-State program, but for the most part forestry aid and guidance is not available to thousands of small owners and operators.

To afford technical services on an adequate scale, experienced professional foresters will be employed to work with individual owners in putting their woodlands under management. Each forester will serve about 150,000 acres of woodland. He will advise farmers on needed cultural operations, make surveys and management plans, mark timber or train owners to do it, assist in locating markets, and advise on marketing arrangements and proper logging techniques. He will also cooperate with extension personnel and others in educational and demonstration work to encourage as many owners as possible to follow proper forestry practices.

The states will participate in providing technical services on woodland. **The Federal Government will bear up to 50 percent of the cost of this measure, with the States bearing the remainder.**

<u>Tree Planting for Cover Restoration</u>

Recommendations provide for planting trees on 70,900 acres of open land to be retired from agriculture, and on 97,000 acres of badly understocked woodland.

This is a most essential measure for quickly stabilizing soils and reducing damaging runoff from poorly protected open lands and sparsely-stocked woodland. In this region, the best watershed cover is produced by mixed tree stands, and eventually these will be developed over most of the area. Initial restocking, however, must be done with coniferous species, since the bulk of the planting sites is presently not suitable for desirable hardwoods.

Recommended species include: white, loblolly, and shortleaf pine in the Mountain-Foothills area and loblolly and shortleaf pine in the Piedmont. On open sites trees will be spaced about 6 x 6 feet. This will require approximately 20 percent more trees per acre than conventional planting practice, but the closer spacing shortens the

time required to produce a dense watershed cover and assures better formed trees for future crops.

On average woodland planting sites, about 600 trees will be planted per acre--roughly half the number required for a complete planting job on open lands. Plantings will be made only in natural openings. No advance poisoning or girdling of weed trees is contemplated, since the primary aim of this measure is to produce denser and more vigorous stands.

On some sites release cuttings may be required after seedlings are established to insure growth and survival. The cost of such release work is included as a planting cost.

Tree planting is popular among landowners in this area, and estimates indicate that at current rates a substantial part of planting needs will be met during the next 15 years under going programs. To accelerate tree planting consistent with recommendations herein, it is proposed that the Federal Government bear 25 percent of the planting cost, and private owners the remainder. On lands to be acquired the Federal Government will bear the entire cost.

Public Acquisition of Watershed Lands

Public acquisition of approximately 320,000 acres of badly depleted critical headwater area is an important implementing measure in accomplishing other recommendations in aid of flood control.

Lands to be acquired are those clearly unsuited to permanent private ownership and usable only as forest. Public ownership insures the continuity of management necessary for the rehabilitation of cover for runoff and sedimentation control.

Lands to be acquired are located within the existing Chattahoochee, Nantahala, and Sumter National Forests. These areas constitute the rougher, least productive portions of the watershed, where high percentages of the land are unsuitable for cultivation or pasture. Within such areas, lands will be acquired when offered for sale by the owners at reasonable prices. It is not contemplated that any lands suitable for permanent use as cropland or pasture will be acquired. A large proportion of the area to be purchased is rough, unmanaged mountain land, in non-resident ownership.

Public purchase of land does not, of itself, improve watershed values or productive capacity of the land, but is an essential first step before the rehabilitation job can be undertaken. Only the public can provide stable, conservative management and defer returns over the long period required to rehabilitate badly depleted lands of this character.

The cost of acquiring the 320,000 acres was estimated at $4,800,000--all Federal. This was based on an average price of $15.00 per acre, and includes the costs for surveys, appraisals, title work, and other expenses of processing.

The annual cost of improving, protecting, and managing these lands after purchase is included under a separate measure in this report.

Development and Management of Lands to be Acquired

This measure provides for management activities contributing to cover improvement, other than those separately discussed herein, for the 320,000 acres of lands to be purchased. Installations include buildings, transportation facilities, communication lines, and other needed improvements. Annual operations include the technical management of timber, watershed and other resources as well as the maintenance of administrative improvements and related facilities. 1/

Existing administrative improvements on the Nantahala, Chattahoochee, and Sumter National Forests are reasonably adequate and have been given due consideration in estimating the additional needs. All costs for this measure are Federal.

This cost amounts to $416,000 for installations and $360,000 for operation and maintenance during the installation period. The annual cost of operation and maintenance after the installation period is estimated at $48,000 annually.

Other Conservation Practices and Measures

Additional soil and water conservation practices and measures will be applied as needed for obtaining a proper combination with the mutually supporting measures listed above. These additional measures serve to complete a basic system of soil and water conservation and proper land use in accordance with the needs and capabilities of the land of the watershed. This will include other farm and woodland practices and measures that may be required to make more effective or facilitate the installation of the above measures. This will produce a practical, workable combination of measures that will be most efficient in providing runoff and waterflow retardation and soil erosion prevention.

GROUP 2 MEASURES - SUPPLEMENT TO LAND TREATMENT

Tributary Channel Improvement and Stream Bank Stabilization

A survey was made on sample tributaries of the Savannah River Watershed to ascertain the present condition of the tributary stream channels and the kinds and amounts of channel improvement measures which would be effective in alleviating flood damages.

The following tributary streams were selected as representative sample tributaries within the Physical Land Units: The Keowee River above stream gage near Newry, South Carolina, to represent streams in the Mountain-Foothills area; Little River above stream gage near Mt. Carmel, South Carolina, to represent the small streams in the Piedmont area; Broad River above stream gage near

1/ Fire protection is not included, being provided for elsewhere; nor are recreation and other facilities which are not closely related to improvement of watershed cover.

Bell Georgia, to represent the large streams in the Piedmont area; Brier Creek was selected to represent the Coastal Plain Streams (figure E-1).

Present Condition of Sample Tributary Streams

In general, only minor aggradation has taken place in the stream channels of the Mountain-Foothills. The banks and side slopes are covered with heavy growth of briars, bushes, vines, and trees, which keeps them fairly stable.

Dredging operations consisting of channel enlargement and realignment have been completed on several of the tributary streams in the Piedmont Plateau. The upper reaches of Broad River are a sample of these streams with little maintenance subsequent to dredging. The channels have been aggrading at a moderate rate.

Only minor aggradation has taken place on Little River. The banks and side slopes of channels are covered with a heavy growth of briars, bushes, vines, and trees.

The bottom lands along Brier Creek are poorly drained, practically all of it being inherently wet. No open land was observed along Brier Creek. Its gradient is very low.

Recommended Channel Improvements

Channel improvement is recommended for most of the tributary streams in the Mountain-Foothills and the Piedmont Plateau. This improvement consists of snagging, removal of log and debris dams, and brushing, as well as the removal of trees from stream channels and banks. Logs and brush will be removed from the floodway to avoid future clogging of the channels. The specific location and timing of these measures will be determined after detailed flood routing studies are made.

Dredging and realignment is recommended for about one-half of the tributary stream channels in the Piedmont Plateau.

In addition to dredging, realigning, clearing, and snagging operations, it will be necessary to suppress the growth of brush and saplings. The suppressive vegetation will stabilize the side slopes of the channels.

Scope of Channel Improvement Operations

The type and amount of channel improvement found beneficial and necessary for the sample tributary streams was expanded to embrace all the tributary streams in the physical land units.

In the Mountain-Foothills Physical Land Unit, channel improvement consisting of brushing and snagging operations, as well as the establishment and maintenance of suppressive vegetation, will be required on the 600 miles of tributary streams.

In the Piedmont Plateau Physical Land Unit, channel dredging and realignment will be necessary on 540 miles. Brushing, snagging, and the establishment of suppressive vegetation will be necessary on 560 miles.

These channel improvement operations will increase channel capacity, reduce flood damages and future maintenance costs.

It is contemplated that the landowners will be responsible for the removal of logs and other debris from the floodway during the initial clearing operations. Also, they will be responsible for the planting of suppressive vegetation and subsequent brushing, as well as annual maintenance.

UNIT COSTS OF OPEN LAND MEASURES

Unit costs for the installation and annual maintenance of the recommended measures were computed from available data and information. Sources of this information included Federal and State Experiment Stations, Soil Conservation Service technicians, contractors, and others within or near the watershed. Unit costs are estimates as to types and quantities of labor and materials needed and are based on 1947 average prices.

The estimated initial cost per unit for installation and maintenance of recommended open land measures is shown in Table E-3.

Installation and annual maintenance costs are divided between Federal, non-Federal Public, and Private sources according to the expected contributions and benefits (Table D-23, Appendix D).

ACTIVITIES RELATED TO FLOOD CONTROL

The Corps of Engineers

The Corps of Engineers has made investigations of the Savannah River and its tributaries to determine the feasibility of a comprehensive plan for the development of its water resources. A report covering navigation, flood control, power development, and irrigation is printed as House Document No. 64, Seventy-fourth Congress, First Session. Subsequent reviews, Senate Document No. 66, Seventy-sixth Congress, First Session and Document No. 6, Eighty-first Congress, First Session, have been made.

As authorized by the Flood Control Act approved June 22, 1936, the Corps of Engineers have made a preliminary examination and Flood Control Survey. This report is printed as House Document No. 657, Seventy-eighth Congress , Second Session.

As a result of the survey the following sites were selected for flood control and multiple purpose reservoirs: Anthony Shoals, Camp Creek, Clark Hill, Goat Island, Hartwell, Middletown Shoals, Newry-Old Pickens, Rogues Ford, Sand Bottom, Tallow Hill, and War Woman.

Authorization for the construction of the Clark Hill and Hartwell Reservoirs has been made. Clark Hill was approved December 22, 1944, in Public Law 534, Seventy-eighth Congress, Second Session, and Hartwell, April 28, 1950, in Report 1968, Eighty-first Congress, Second Session. The Clark Hill dam is under construction.

Navigation is maintained between Savannah and Augusta, a distance of approximately 200 river miles.

Private Power Development

The Georgia Power Company has developed a series of six power dams on the Tallulah and Tugaloo Rivers. Present operation of these reservoirs contributes to flood reduction to some extent, since the power company has on occasion drawn down the pools in anticipation of high flow during storm periods.

Woodland Management

The Federal and State Governments are cooperating in organized fire control and in the production and distribution of forest tree seedlings under the Clarke-McNary Act. Farm forestry services are also provided under the Norris-Doxey Act. Under the provisions of Public Law 729, 81st Congress, 2d Session, which will supersede the Norris-Doxey Act on June 30, 1951, these services have been broadened to include technical aid to non-farm forest owners and operators.

Educational Activities and Direct Aids

Federal and State Experiment Stations within or near the watershed supply valuable information and data on measures and practices related to flood control and conservation of watershed lands. The agricultural colleges, vocational agricultural schools, and the U. S. Department of Agriculture Cooperative Extension Service have obtained local recognition of many farm problems and have also rendered valuable assistance by educating the public to appreciate the need for conservation measures. The Production and Marketing Administration makes conservation payments and materials available to individual farmers for carrying out soil and water conservation practices. State and Federal forestry agencies are also carrying on educational activities among forest owners and operators.

Soil Conservation Districts

North Carolina, South Carolina , and Georgia have enacted legislation whereby more than 98 percent of the total watershed lands are in active soil conservation districts. The U. S. Department of Agriculture cooperates with these districts to the extent of supplying technical assistance through the Soil Conservation Service. The soil and water conservation program as promoted by these districts is an integral part of the recommended program.

State Highway Departments

The State Highway Departments of North Carolina, South Carolina, and Georgia are aiding in the prevention of sedimentation in many places by sloping and stabilizing cuts and fills. It is anticipated that no difficulty will be experienced in obtaining their full assistance in carrying out the proposed program.

United States Department of Commerce

The U. S. Weather Bureau has a useful river service, centered at the Augusta Weather Bureau Office, for forecasting gage heights during floods. It is not expected that any changes in this service will be made as a result of the recommended program.

Private Interests

District supervisors, technicians, and other agricultural and conservation leaders present at various meetings and contacts within the watershed agree that the recommended program is feasible. They are of the opinion that a high percent of the landowners would cooperate if the recommended program is authorized.

Railroad companies have already treated much of their rights-of-way for erosion control, and it is believed that they will cooperate in completing the program.

COST OF "GOING" PROGRAMS 1/

Soil Conservation Service in Cooperation with Soil Conservation Districts

The fiscal year 1949 was used as a base for estimating the annual cost (including administrative and facilitating services) of the Soil Conservation Service assistance to districts. The cost was determined by proportioning total personnel and facilitating costs on a basis of the percentage of watershed farm land in each district. Personnel cost represents salaries paid to local technicians. Facilitating cost represents transportation, office rent, supplies, administrative and technical supervision and related assistance. The estimated annual cost is $226,800, or a total cost of $3,402,000 for a 15-year period.

Cooperative Extension Service

Copies of supporting correspondence which was used as a base in estimating accomplishments and costs of this part of the "going" programs are shown on pages 17 through 24.

Additional information obtained in other correspondence with State Extension Services in North Carolina, South Carolina, and Georgia was used in arriving at the following summary of total costs by states and by sources of funds:

State	Source of Funds		Total Expenditure
	Federal	State and Local	
North Carolina	$18,677	$ 27,553	$ 46,230
South Carolina	257,843	123,028	380,871
Georgia	253,069	160,832	413,901
Total	$529,589	$311,413	$841,002
Annual	$ 35,303	$ 20,761	$ 56,064

1/ Adjusted to exclude the Coastal Plain area.

Production and Marketing Administration

Copies of supporting correspondence which was used as a base in estimating accomplishments and costs of this part of the "going" programs are shown on pages 25 through 32.

Additional information obtained in other correspondence with State Production and Marketing Administration offices in North Carolina, South Carolina, and Georgia was used in arriving at the following summary of annual costs by states:

North Carolina	$ 25,144
South Carolina	81,791
Georgia	504,574
Total	$586,365

The total cost for a 15-year period amounts to $8,795,475.

Forest Service

Data furnished by the Forest Service show the annual Federal costs of going programs in the Piedmont and Mountain-Foothills portions of the watershed for adequate fire protection, tree planting for cover restoration, cover improvement of privately-owned woodlands, public acquisition, and development and management of public forest lands as $323,200.

COOPERATIVE EXTENSION WORK
IN
AGRICULTURE AND HOME ECONOMICS
State of North Carolina
P. O. Box 5157
State College Station
Raleigh, N. C.

Extension Service
Office of the Director

May 1, 1950

Mr. H. G. Edwards, Chief
Regional Water Conservation Division
Soil Conservation Service
Post Office Box 612
Spartanburg, South Carolina

Dear Mr. Edwards:

On April 14, at your request, I sent you an estimate on the expenditures of the North Carolina Agricultural Extension Service for conservation measures during 1949 in the Savannah River Watershed. I also enclosed two pieces of material both of which were labeled as Exhibit A, but should have been labeled Table IV and Explanation to Table IV respectively.

At that time I did not indicate that any additional Extension Resources would be required, but following a conference with Mr. Loy E. Rast and Mr. J. E. McLean on April 27th, we feel that a limited amount of additional resources will be required; therefore, we are revising our estimate as shown in Table III on the enclosed sheet.

It will be appreciated if you will substitute this for our estimate of April 14 and make the changes with respect to Table IV and Explanation to Table IV.

Yours very truly,

/s/ I. O. Schaub

I. O. Schaub
Director

IOS/b

Enclosure

ESTIMATE OF EXPENDITURES BY THE N. C. AGRICULTURAL EXTENSION SERVICE FOR CONSERVATION MEASURES DURING 1949 AND ADDITIONAL RESOURCES REQUIRED FOR "FLOOD CONTROL" ACTIVITIES IN THE SAVANNAH WATERSHED

TABLE I

Estimate of Expenditures for 1949

County Agents and Specialists	$2832.00
Administration, Supervision and Supplies	250.00
Total Estimated Expenditures	$3082.00

TABLE II

Estimate of Proportion of Total Expenditures During 1949 from Different Sources

	Percent	Amount
Federal Appropriations	40.4	$1245.13
State Appropriations	36.2	1121.85
County Appropriations	23.2	715.02
Total	100.0	$3082.00

TABLE III

Estimate of Additional Extension Resources Required

	Cost for Additional County Agts.	Cost for Additional Spec. Asst.	Total
For 20-Year Period	$8,000	$2,000	$10,000
Average Cost Per Year		$500.00	

TABLE IV

ESTIMATE OF EXPENDITURES BY THE N. C. AGRICULTURAL EXTENSION SERVICE DURING YEAR 1949 FOR ACTIVITIES IN RELATION TO RUN-OFF AND WATER-FLOW RETARDATION AND SOIL EROSION PREVENTION IN THE SAVANNAH RIVER BASIN AREA

COMPUTATIONS WERE MADE FROM COUNTY AGENTS' REPORTS AND BUDGET

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Counties	Total Days Worked by Co. Agts.	% of Total Days County Agents Devoted to Conserv.	Amount of Co. Agents Budget Expended for Conserv. Work	Cost of Spec. Asst.	Total Cost of Conserv. Work Done by Agts. & Spec.	% Land Area of County in Watershed Area	Total Expenditures for Conserv. Work in Watershed Area
Clay	709.5	32	4402	990	5392	5.5865	301
Macon	792.5	35	6090	2100	8190	4.1526	340
Jackson	599.5	30	5020	1230	6250	13.7431	859
Transylvania	564.0	31	4639	1950	6589	20.2094	1332
	2665.5	32	20151	6270	26421		2832

TABLE IV

ESTIMATE OF EXPENDITURES BY THE N. C. AGRICULTURAL EXTENSION SERVICE DURING THE CALENDAR YEAR 1949 FOR ACTIVITIES IN RELATION TO RUN-OFF AND WATER-FLOW RETARDATION AND SOIL EROSION PREVENTION IN THE SAVANNAH RIVER WATERSHED

Explanation of the Attached Chart -

Column 1 - Total Days Worked by County Agents. This is the total days worked by the County Agents and their Assistants during the year.

Column 2 - Percentage of Total Days County Agents Devoted to Conservation Measures. Percent of the total days worked which were devoted to conservation measures.

Column 3 - Amount of County Agents' Budget Expended for Conservation Work. Represents that part of the total budget for County Agents which was expended for conservation work. The entries in this Column were determined by applying the percentage figure shown in Column 2 to the total budget for the County Agents in each County.

Column 4 - Cost of Specialists Assistance. Entries in this column were determined on the basis of days Specialists devoted to work of a Conservation nature and the average cost per day.

Column 5 - Total Cost of Conservation Work Done by County Agents and Specialists. This is the total of Columns 3 and 4.

Column 6 - Percent of Land Area of County in Watershed Area. The entries in this column were obtained from Mr. H. G. Edwards, Chief, Regional Watershed Division, and represent the actual percent of the land area in each County as planimetered from a base map and adjusted to the Area.

Column 7 - Total Expenditures for Conservation Work in Watershed Area. The entries in this column are the same percentage of the total cost as the percentage of the County which is in the Savannah River Watershed.

Cooperative Extension Work
in
Agriculture and Home Economics
State of South Carolina

Clemson, South Carolina
July 10, 1950

Mr. H. G. Edwards
Engineer in Charge, Flood Control
Regional Office
Soil Conservation Service
Spartanburg, South Carolina

Dear Mr. Edwards: Subject: An Estimate of Extension Work Necessary in an Accelerated Program of Flood Control in Savannah River Watershed

The entire Savannah River watershed covers 6,770,560 acres of which 42.8 percent or 2,899,200 acres lie in fourteen South Carolina counties. The two counties of Oconee and McCormick lie 100 percent in this watershed while the other twelve counties fall from 4.4 percent in Beaufort to 85 percent in Abbeville within the watershed. We estimate about 21,567 farms in the South Carolina part of the watershed. Some contacts would be made with each of these and some work accomplished on each farm of owner and tenant. Our assumption is that each land owner and to some extent each tenant will under an accelerated flood control program continue to be steward of his lands and as such will retain responsibility for flood control work carried out on his lands. This assumption applies with respect to measures which the farmer will put into use on his own, as well as to measures that the federal government will finance. Thus the main problem in establishing a flood control program on a farm or on the farms in a watershed consists of educational and demonstration work that convinces each such farmer that the proposed measures to be applied to his lands are right from his own standpoint and from the public standpoint. This is the job for which I made our original estimate of costs. In making the estimate of the necessary personnel and budget for additional Extension work, I realized that there is a constant turnover among the farmers responsible for establishing and maintaining flood control measures. Such turnover means that we will have not just 21,567 farmers to work with but perhaps twice that number during a twenty-year period, if a fairly good situation as to flood control is to be a reality at the end of the period.

You were kind enough at our conference in my office to leave with me a copy of Table E-2, showing your own analysis of the "Needs", what will be accomplished by means of the "Going Program", and what remains to be provided through a new "Recommended Program". I take it that you are fully aware of some weaknesses in this set of estimates even though the procedure itself has merit. May I indicate a few of my own observations on this Table E-2:

(1) In arriving at "Needs" apparently the entire basis is "land capabilities". Since the land is largely occupied by farm people the real problem will be to fit their living requirements into the accelerated program. The use of the land will vary with markets and farm income

from the products of the land. We estimate that the Extension Service is now spending $34,608.80 annually in the South Carolina part of the Savannah watershed on activities that contribute to flood control. This includes work in tree planting and forest management, terracing, pasture establishment and improvement, etc., but

(2) The amount being spent at present will not accomplish what is shown in the table under the "Going Program" in my opinion. This applies especially to items (5) Terracing (8) Pasture improvement, and (9) Pasture establishment.

On the other hand it seems that the figures are too low on the item under "Woodland" (1) Forest fire protection. In South Carolina, all landowners are now furnished forest fire protection assistance. Most woods fires are set which means that the main job to be done is in the way of thinking among people supported with a reasonable amount of facilities. The going program of education, demonstration, regulation, and service should accomplish more than the total estimated to be accomplished of 499,000 acres under fire control even if none were accomplished outside this state. Also under "Woodland", item (3) apparently puts no value on the large amount of work being accomplished annually by the Extension Service in connection with the "Improvement and Proper Management of Privately-owned Woodlands". Our official annual Extension reports on Forestry will show that much is being accomplished in this field as in the fields mentioned in the preceding paragraph, County agents and Extension specialists are at work on this forestry job in exactly the same way as on the other items. Yet this Table E-2 shows that practically nothing is to be expected under Forestry Improvement and Management while the job will be almost completed under the other items. I am quite confident that Table E-2 is far from what will be accomplished by going programs in both cases.

Naturally, therefore, I cannot base my estimate of Extension Service needs on what is shown in the last column of this table under the "Recommended Program". If I had made up such a table it would be quite different in the above mentioned respects. I think my original estimate of costs for Extension work will prove to be not far from correct. However, it is, of course, impossible to say with exactness just what a job of work lasting over such a long period of time will cost, even though we should agree perfectly on what that job is. Under these circumstances, realizing that you are working against time in making your report, and not wishing to quibble over questions that cannot be answered with certainty, I am arbitrarily cutting down my first estimate of Extension costs to a flat $500,000. I am willing for this amount to be estimated for us and for it to be divided among the fourteen counties in proportion to the percentage of the watershed in South Carolina that falls in each county. Since there is no basis for assuming that any part of this amount would be available from state or local sources, I would assume that it would all be a federal expense.

Only experience will show whether this amount is too little (as I believe) or too much. But I cannot conscientiously promise that this accelerated job can be done largely through the going program which is already overburdened with demands for service.

Sincerely yours,

/s/ D. W. Watkins
D. W. Watkins
Director

C O P Y

COOPERATIVE EXTENSION WORK
IN AGRICULTURE AND HOME ECONOMICS
State of Georgia

Regents of the University of Georgia and the United States Department of Agriculture, Cooperating

GEORGIA AGRICULTURAL EXTENSION SERVICE
Athens
June 29, 1950

Mr. H. G. Edwards
Chief, Regional Water
Conservation Division
Regional Office
Soil Conservation Service
Spartanburg, South Carolina

Dear Mr. Edwards:

In line with a verbal request by Mr. Rast and Mr. McLean of your office, I am providing the following information as an amendment to my letter to you of June 15th to which was attached a statement entitled "Expenditures and Proposed Additional Resources By The Georgia Agricultural Extension Service For Educational Work on Flood Control Activities, Including Runoff and Waterflow Retardation and Soil Erosion Prevention in the Savannah River Watershed".

Attached to this letter and submitted as an amendment, as indicated above, is a table showing the estimated expenditures of the Georgia Agricultural Extension Service for educational work on conservation of water and soil in the Savannah River Watershed for 1949 and a projection of these expenditures for the anticipated 15-year installation period. As you will note, the estimated expenditures for the 15-year period totals $555,760.35. Funds of federal origin will constitute about 61 percent of these costs while those from state and county sources will be about 39 percent of the expenditures.

The estimated additional resources needed during the anticipated 15-year installation period in the Savannah River Watershed by the Georgia Agricultural Extension Service will amount to $204,435.00. This is an average additional resource need of $13,629.00 per year. All of these additional funds must be of federal origin. There is no basis for assuming that any part can or will come from state and county sources.

These estimated additional federal funds for an accelerated educational program on flood control in the Savannah River Watershed were determined in line with suggestions made by Mr. Rast and Mr. McLean of your office and those contained in a letter of June 5 from Director M. L. Wilson addressed to State Extension Directors entitled "Educational Requirements With Relation To Department of Agriculture Activities Under The Special Flood Control Legislation".

If you find that additional information is needed, please advise us and we shall be glad to provide such other facts as we can.

Sincerely yours,

/s/ W. S. Brown

W. S. Brown
Director

WSB:JWF:j

C O P Y

Regional Office
Spartanburg, South Carolina

July 11, 1950

Mr. D. W. Watkins
Director
South Carolina Extension Service
Clemson, South Carolina

Dear Mr. Watkins:

This will acknowledge your letter of July 10, 1950, containing estimate of extension work necessary in accelerated program of flood control on that portion of the Savannah River Watershed in South Carolina, together with estimate of annual cost of your "going" program.

We appreciate the difficulties you encountered in preparing the estimate of cost for the accelerated program. The information furnished will permit us to complete a revised draft of the Savannah River Survey Report within the next few weeks. We find it will be necessary to revise your estimate of cost for the accelerated program in South Carolina consistent with our interpretation of watershed needs for the proposed 15-year period of installation.

As soon as draft survey report has been prepared you will be afforded an opportunity to review the report and appendixes and make appropriate comments.

Thanking you for your cooperation and interest in this matter, I remain

Sincerely yours,

/s/ H. G. Edwards

H. G. Edwards
Chief, Regional Water
Conservation Division

C
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UNITED STATES DEPT. OF AGRICULTURE

PRODUCTION AND MARKETING ADMINISTRATION

State College Station
Raleigh, North Carolina
April 7, 1950

Mr. H. G. Edwards
Chief, Regional Water Conservation Division
Soil Conservation Service
U. S. Department of Agriculture
Spartanburg, South Carolina

Dear Mr. Edwards:

As requested in your letter of March 28, 1950, there is attached information desired on the Savannah River Watershed Area in North Carolina.

Very truly yours,

/s/ G. T. Scott

G. T. Scott, State Director
Production and Marketing Adm.

Attachment

PRESENT ANNUAL RATE OF FEDERAL CONTRIBUTIONS UNDER THE AGRICULTURAL CONSERVATION PROGRAMS FOR THE SAVANNAH WATERSHED AREA IN NORTH CAROLINA

PRACTICE	UNITS	CONTRIBUTION INCLUDING ADMINISTRATIVE EXPENSES
1. Terracing	0	
2. Farm Ponds	0	
3. Perennials (Kudzu, Sericea, and Alfalfa	32 acres	$ 902
4. Drainage	109 acres drained	302
5. (a) Establishing Pastures	782 acres	13,621
(b) Improving Pastures	783 acres	10,229
6. Sod Waterways	0	
TOTAL		$25,054
Establishing Red, Alsike and sweetclover (which is not included in the above total)	15 acres	$ 90

COPY

UNITED STATES DEPARTMENT OF AGRICULTURE
Production and Marketing Administration
Columbia, South Carolina

May 19, 1950

Mr. H. G. Edwards
Chief, Regional Water Conservation Division
United States Department of Agriculture
Soil Conservation Service
Spartanburg, South Carolina

Dear Mr. Edwards:

As requested by Mr. J. E. McLean of your office in a conference with me today, I am transmitting tabulations, by counties, showing the following information:

1. Extent of Certain Conservation Practices Carried Out in Savannah Watershed Area For Which Payment was Made Under the 1949 Agricultural Conservation Program.

2. Total Costs (Including Administrative Expense) in Carrying Out Specified Conservation Practices in 1949 in Savannah Watershed Area.

Very truly yours,

/s/ R. W. Hamilton

R. W. Hamilton
Chairman, South Carolina
State PMA Committee

Enclosures

Extent of Specified Conservation Practices Carried Out in 1949 in Savannah Watershed Area

County	Terracing (Ft.)	Kudzu (Acre)	Lespedeza Sericea (Acre)	Establishing and Improving Pastures (Acre)	Drainage (Acres Benefited)	Planting Trees (Acres)
Abbeville	357,330	47	86	640	82	41
Aiken	485,475	45	480	360	50	202
Allendale	86,740	1	45	142	810	207
Anderson	717,140	43	351	2,572	10	22
Barnwell	155,544	25	300	315	340	255
Beaufort	-	-	-	12	16	-
Edgefield	570,140	-	83	300	67	392
Greenwood	15,218	-	59	407	-	52
Hampton	-	4	16	82	1,210	104
Jasper	-	3	-	9	330	203
McCormick	330,576	-	30	930	-	100
Oconee	110,523	140	105	625	-	78
Pickens	225,566	12	69	397	-	14
Saluda	24,746	-	5	64	0	3
	3,559,050	320	1,629	6,855	2,915	1,673

Total Costs (Including Administrative Expense) in Carrying
Our Specified Conservation Practices
in 1949 in Savannah Watershed Area

County	Terracing	Kudzu	Lespedeza Sericea	Establishing and Improving Pastures	Drainage	Planting Trees	Total Cost
Abbeville	$ 8,960	$ 264	$ 649	$ 5,171	$ 76	$ 133	$ 15,253
Aiken	5,220	263	3,941	2,399	116	725	12,664
Allendale	919	3	357	1,018	675	730	3,702
Anderson	7,674	258	2,757	18,266	44	77	29,076
Barnwell	1,647	148	2,325	1,361	553	893	6,927
Beaufort	-	-	-	123	14	-	137
Edgefield	6,259	-	640	2,602	124	1,433	11,058
Greenwood	170	-	403	1,742	-	192	2,507
Hampton	-	19	141	397	1,024	373	1,954
Jasper	-	19	-	113	589	775	1,496
McCormick	3,880	-	208	6,929	-	391	11,408
Oconee	1,245	869	815	4,059	-	295	7,283
Pickens	2,558	73	569	2,489	-	52	5,741
Saluda	275	-	42	294	0	10	621
Totals	$ 38,807	$1,916	$12,847	$46,963	$3,215	$6,079	$109,827

COPY

UNITED STATES DEPARTMENT OF AGRICULTURE
PRODUCTION AND MARKETING ADMINISTRATION
Georgia State Office
Athens, Georgia

May 1, 1950

Mr. H. G. Edwards, Chief
Regional Water Conservation Division
Soil Conservation Service
Spartanburg, South Carolina

Dear Mr. Edwards:

Reference is made to your letter of March 28, enclosing a copy of information needed in connection with the Savannah River Watershed Flood Control Report.

Of the measures you have listed as measures recommended for erosion control and reduction of floodwater and sediment damage, assistance has been given for the following under the Agricultural Conservation Program:

- Terracing
- Farm Ponds (for Livestock Water or Irrigation)
- Pastures
  - Old pastures improved
  - New pastures established
- Perennial vegetation (Kudzu and Lespedeza Sericea)
- Tree Planting

Attached is a tabulation, in duplicate, showing the estimated annual rate of establishment of the above measures or practices under the Agricultural Conservation Program, for the Georgia portion of the Savannah Watershed. This estimate is based on accomplishments under the 1947 ACP, the most recent normal program year for which complete data are available. We have made one exception, however. The estimated annual acreage for tree planting is based on plantings during the 1947-1948 planting season, for which assistance was given under the 1948 ACP. The previous year was abnormal in that there was a serious shortage of tree seedlings in the State.

As you requested, we have tabulated the data by counties. The extent shown for each practice is the total extent for the county times the percentage of the county that is in the watershed. The acreage figures we are reporting for old pastures improved and new pastures established have been determined by estimate from our statistics, which show the total acreage of pasture receiving seed, lime, or fertilizer. The acreage we have listed for new pastures established is the acreage on which a seed mixture containing one or more perennial pasture plants was seeded. The acreage shown for old pastures improved is the total acreage receiving one or more of the following treatments: reseeding, liming, fertilizer containing phosphorus or potash. The cost shown under this item is a weighted average, taking into consideration the estimated number of acres receiving the respective treatments.

2-Mr. H. G. Edwards-5-1-50

The Federal cost shown for each group of practices is composed of the net payment rate for the practice under the ACP, the average amount of small payment increase earned by the practice, and the administrative cost.

If there is any question concerning any of the attached material or if additional data or estimates are needed, we shall attempt to comply with any request promptly.

Very truly yours,

/s/ T. R. Breedlove

T. R. Breedlove, Chairman
State PMA Committee

Attachment

Savannah River Watershed - Georgia
Estimated Annual Rate of Accomplishment of
Selected Practices Under the Agricultural Conservation Program

County	Terracing		Farm Ponds		Old Pastures Improved		New Pastures Established		Perennial Vegetation Kudzu		Perennial Vegetation L. Sericea		Tree Planting	
	Miles	Cost	No.	Cost	Acres	Cost	Acres	Cost	Acres	Cost	Acres	Cost	Acres	Cost
Banks	28	$ 2231	0	$ 0	884	$ 5162	416	$ 6240	70	$ 420	250	$ 1200	25	$ 90
Burke	12	950	0	0	2610	15242	546	8190	83	498	59	283	20	48
Chatham	0	0	0	0	521	3043	158	2370	0	0	0	0	0	0
Clarke	1	61	0	0	19	111	18	270	0	0	5	24	0	0
Columbia	60	4754	35	10057	1138	6645	3228	48420	300	1800	200	960	68	245
Effingham	0	0	0	0	265	1548	0	0	0	0	0	0	0	0
Elbert	211	16819	15	4380	1893	11055	2088	31320	126	756	767	3632	42	151
Franklin	214	17053	13	2605	863	5040	588	8820	83	498	475	2270	74	266
Glascock	1	54	0	0	37	216	8	120	4	24	3	14	0	0
Greene	1	54	1	232	249	1454	119	1785	3	18	26	125	0	0
Habersham	5	389	0	0	120	700	77	1155	13	78	12	58	0	0
Hart	229	18328	14	2512	4040	23594	1038	15570	55	330	388	1862	34	122
Jackson	11	843	1	360	62	362	98	1470	4	24	39	187	4	14
Jefferson	8	636	0	0	516	3013	119	1785	30	180	17	82	10	24
Jenkins	1	44	0	0	8	47	21	315	9	54	1	5	6	14
Lincoln	36	2873	7	948	1200	7008	915	13725	4	24	32	154	0	0
McDuffie	44	3475	9	1997	1250	7300	1142	17130	40	240	410	1968	8	29
Madison	145	11608	16	3220	327	1910	673	10095	150	900	610	2928	0	0
Oglethorpe	23	1871	0	0	718	4193	426	6390	34	204	304	1459	43	155
Rabun	0	0	0	0	385	2248	395	5925	0	0	4	19	0	0
Richmond	23	1821	6	2089	1661	9700	1152	17280	42	252	80	584	36	130
Screven	49	3934	0	0	1632	9531	820	12300	41	246	29	139	3	7
Stephens	24	1924	0	0	782	4567	174	2610	32	192	140	672	11	40
Taliaferro	1	80	1	291	2438	14238	1358	20370	12	72	171	821	37	133
Towns	0	0	0	0	0	0	15	225	0	0	0	0	0	0
Warren	21	1715	14	3612	1479	8637	347	5205	35	210	38	132	0	0
Wilkes	53	4200	24	7339	3974	23208	4896	73440	50	300	195	936	0	0
Total	1201	$95,717	158	$39,642	29,071	$169,772	20,835	$312,525	1220	$7320	4253	$20,414	421	$1468

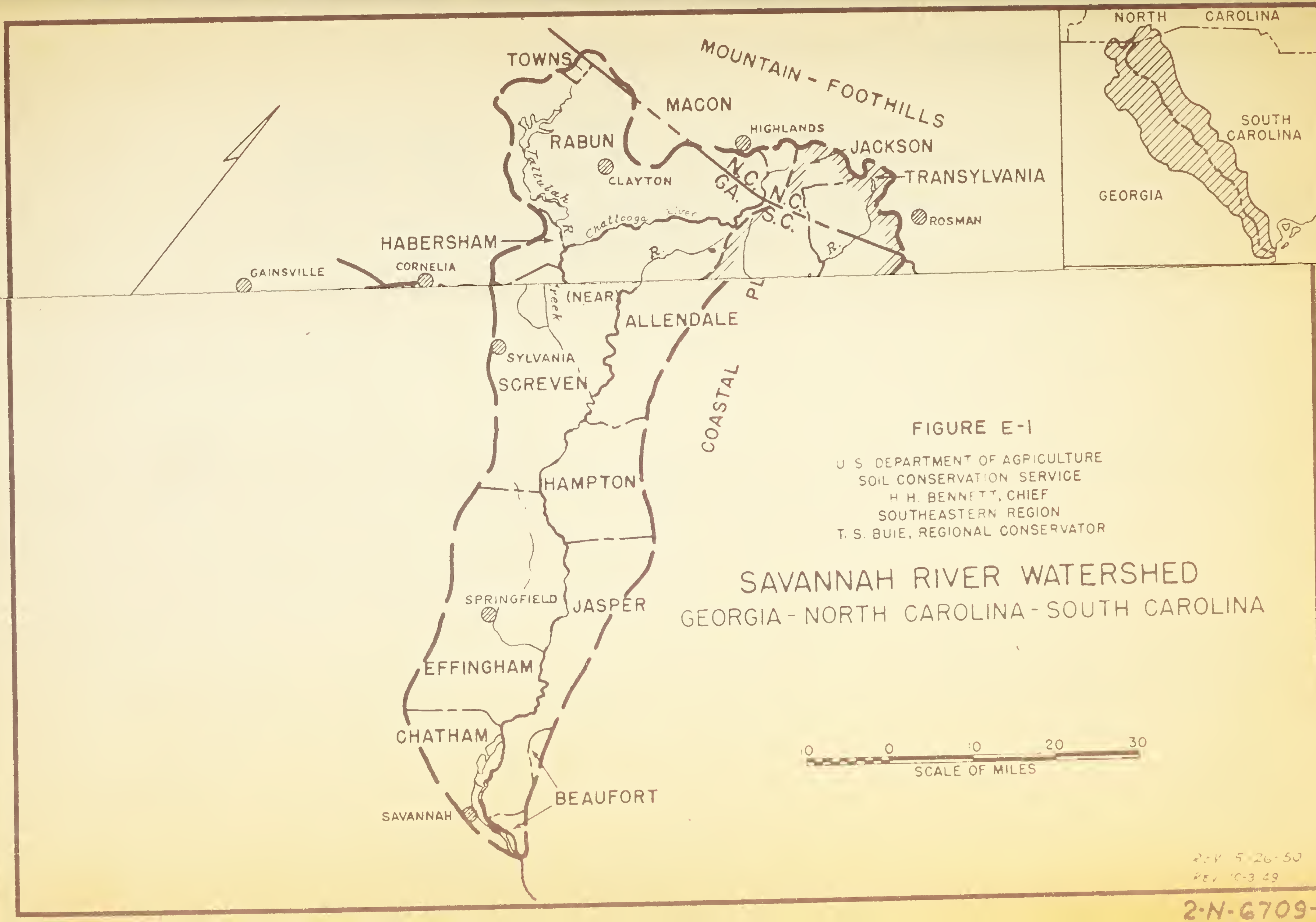

FIGURE E-1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL CONSERVATOR

SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA

FIGURE E-I

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H H BENNETT, CHIEF
SOUTHEASTERN REGION
T S BUIE, REGIONAL CONSERVATOR

SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA

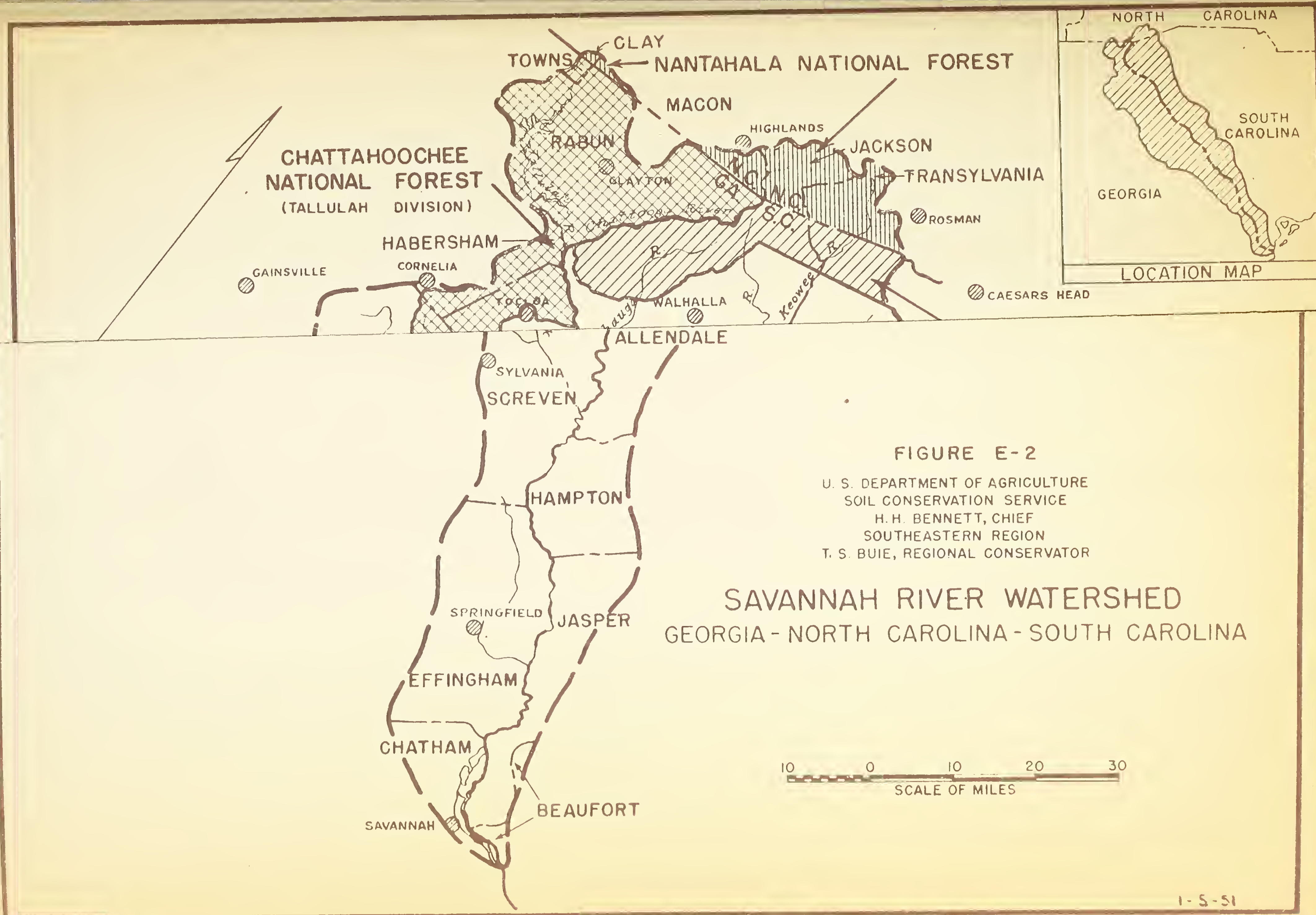

FIGURE E-2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL CONSERVATOR

SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA

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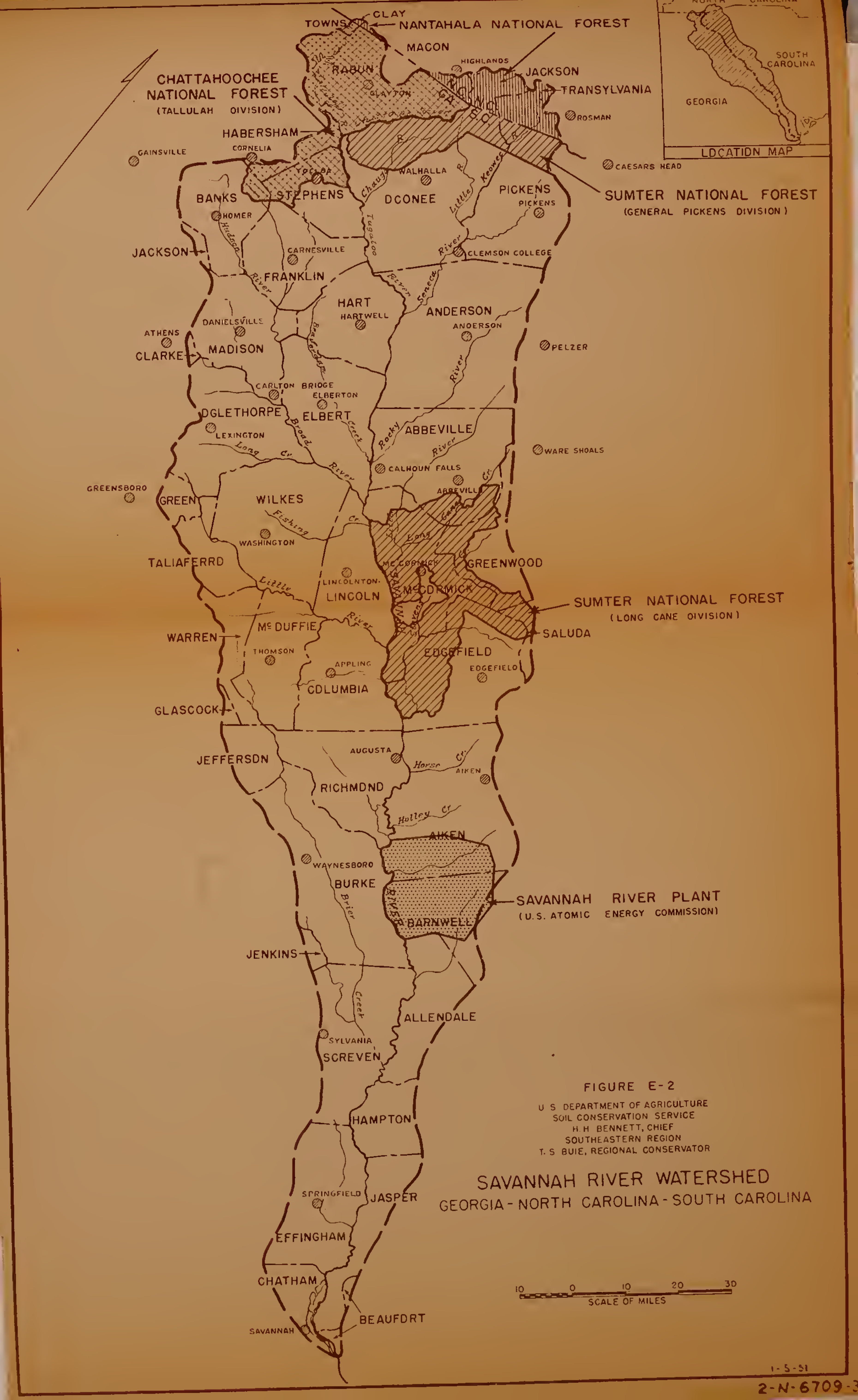

FIGURE E-2

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H.H BENNETT, CHIEF
SOUTHEASTERN REGION
T. S BUIE, REGIONAL CONSERVATOR

SAVANNAH RIVER WATERSHED
GEORGIA - NORTH CAROLINA - SOUTH CAROLINA

Table E-1

Land Use	Mounta Foothi
	Acre
Total Area	911,4
Crop Land 1/	
Present	100,5
Recommended	73,8
Net Change	-26,7
Pasture:	
Present	43,0
Recommended	64,7
Net Change	⁄21,6
Woodland:	
Present	690,2
Recommended	702,3
Net Change	⁄12,0
Perennial Vegetation:	
Present	2,9
Recommended	27,1
Net Change	⁄24,2
Orchard:	
Present	2,0
Recommended	2,0
Net Change	

Piedmont Plateau	Coastal Plain	Total
Acres	Acres	Acres
821	307	1,170
11,211	307	12,493
⁄10,390	0	⁄11,323
271,707	142,472	454,454
0	142,472	142,472
271,707	0	-311,982
207,293	105,545	344,962
207,293	105,545	344,962
0	0	0
merly classed in other uses -		
0	0	0
146	0	3,955
⁄146	0	⁄3,955
1,280	190	1,550
47,383	190	51,957
⁄46,103	0	⁄50,407

1/ Row crops in rotation with sm

2-N-7496-1

Table E-1

PRESENT AND RECOMMENDED LAND USE
SHOWING NET CHANGES
BY PHYSICAL LAND UNITS
SAVANNAH RIVER WATERSHED

Land Use	Mountain-Foothills	Piedmont Plateau	Coastal Plain	Total
	Acres	Acres	Acres	Acres
Total Area	911,470	3,543,980	2,315,170	6,770,560
Crop Land 1/				
Present	100,557	819,528	493,048	1,413,133
Recommended	73,814	685,191	493,048	1,2[illegible],053
Net Change	-26,743	-134,337	0	-161,080
Pasture:				
Present	43,091	284,136	83,348	410,575
Recommended	64,773	425,807	83,348	573,928
Net Change	+21,682	+141,671	0	+163,[illegible]3
Woodland:				
Present	690,285	1,911,208	1,478,558	4,080,051
Recommended	702,356	1,999,051	1,478,558	4,17[illegible]
Net Change	+12,071	+87,843	0	+9[illegible],914
Perennial Vegetation:				
Present	2,960	44,319	6,718	5[illegible],997
Recommended	27,179	164,210	6,718	198,107
Net Change	+24,219	+119,891	0	+144,110
Orchard:				
Present	2,056	3,628	4,934	10,608
Recommended	2,056	3,628	4,934	10,608
Net Change	0	0	0	0

Table E-1

Land Use	Mountain-Foothills	Piedmont Plateau	Coastal Plain	Total
	Acres	Acres	Acres	Acres
Field Borders:				
Present	42	821	307	1,170
Recommended	975	11,211	307	12,493
Net Change	+ 933	+10,390	0	+11,323
Idle Land:				
Present	40,275	271,707	142,472	454,454
Recommended	0	0	142,472	142,472
Net Change	-40,275	-271,707	0	-311,982
Miscellaneous:				
Present	32,124	207,293	10[illegible],545	344,962
Recommended	32,124	207,293	10[illegible],545	[illegible]
Net Change	0	0	0	0
Other Wildlife: (Class VIII land formerly classed in other uses - principally forest)				
Present	0	0	0	0
Recommended	3,809	146	0	3,955
Net Change	+3,809	+146	0	+3,955
Vegetative Waterways:				
Present	90	1,290	190	1,550
Recommended	4,384	47,383	190	51,957
Net Change	+4,304	+46,103	0	+50,407

1/ Row crops in rotation with small grain and close-growing annuals.

Table E-2

SUMMARY OF WATERSHED NEEDS, ESTIMATED ACCOMPLISHMENTS OF "GOING" PROGRAMS FOR FIFTEEN-YEAR PERIOD AND RECOMMENDED PROGRAM SAVANNAH RIVER WATERSHED

Measures	Unit	Needs	"Going" program	Recommended program
Group 1:				
Open land				
1. Subwatershed waterways	Mile	440	--	440
2. Gully stabilization and sediment control	Mile	3,690	--	3,690
3. Erosion control along railroads and roadways	Mile	10,880	--	10,880
4. Field diversions	Mile	1,300	150	1,150
5. Terraces	Mile	57,690	39,600	18,090
6. Perennials	Acre	144,100	128,500	15,600
7. Pasture improvement	Acre	327,200	315,700	11,500
8. Pasture establishment	Acre	163,400	163,400	--
9. Field border plantings	Acre	11,300	2,000	9,300
10. Farm waterways	Acre	45,300	16,700	28,600
11. Water disposal from hill land	Mile	480	480	--
Woodland				
1. Adequate fire protection	Acre	2,701,000	480,000	2,221,000
2. Tree planting for cover restoration				
(a) Private lands	Acre	182,700	43,500	139,200
(b) Lands to be acquired	Acre	28,700	0	28,700
3. Cover improvement, privately-owned woodlands	Acre	1,564,000	1/	1,564,000
4. Public acquisition of watershed lands	Acre	350,000	30,000	320,000
5. Development and management of lands to be acquired	Acre	350,000	30,000	320,000
Group 2:				
1. Tributary channel improvement and stream bank stabilization	Mile	1,720	--	1,720

1/ A limited amount of technical aid is now provided in parts of the watershed under cooperating state-federal programs.

Table E-3

ESTIMATED INITIAL COST PER UNIT FOR INSTALLATION AND MAINTENANCE
OF RECOMMENDED OPEN LAND MEASURES
SAVANNAH RIVER WATERSHED

Measure	Unit	Installation	Annual Maintenance
		Dollars	Dollars
Group 1:			
Open Land			
1. Subwatershed waterways	Mile	1,870	85
2. Gully stabilization and sediment control	Mile	415	35
3. Erosion control along Railroads and roadways	Mile	151	40
4. Field Diversions	Mile	106	24
5. Terraces	Mile	53	12
6. Perennial Vegetation	Acre	36	7
7. Pasture Improvement	Acre	27	10
8. Field Borders	Acre	30	5
9. Farm Waterways	Acre	30	5
Group 2:			
1. Tributary Channel Improvement and Stream Bank Stabilization	Mile	1,925	40